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THE PRACTICAL ENGINEER

VOL. VIII. Philadelphia. October. 1904 No. 9

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1904

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The above statement is in itself a story well worth printing. It tells of a steady growth in clean paid circulation, seldom, if ever equalled in a similar period by any mechanical journal, and in the total only a little less than that of our oldest contemporaries who have spent half a lifetime in the field. The principal reason for its rapid growth appears to be that The Practical Engineer is a popular engineers' paper at a popular price. Whether this is the reason or not, we intend to constantly improve and enlarge The Practical Engineer just as we have done in the past and we trust that our readers will help us to still further increase its circulation. It will be devoted always to the best interests of operating stationary engineers.

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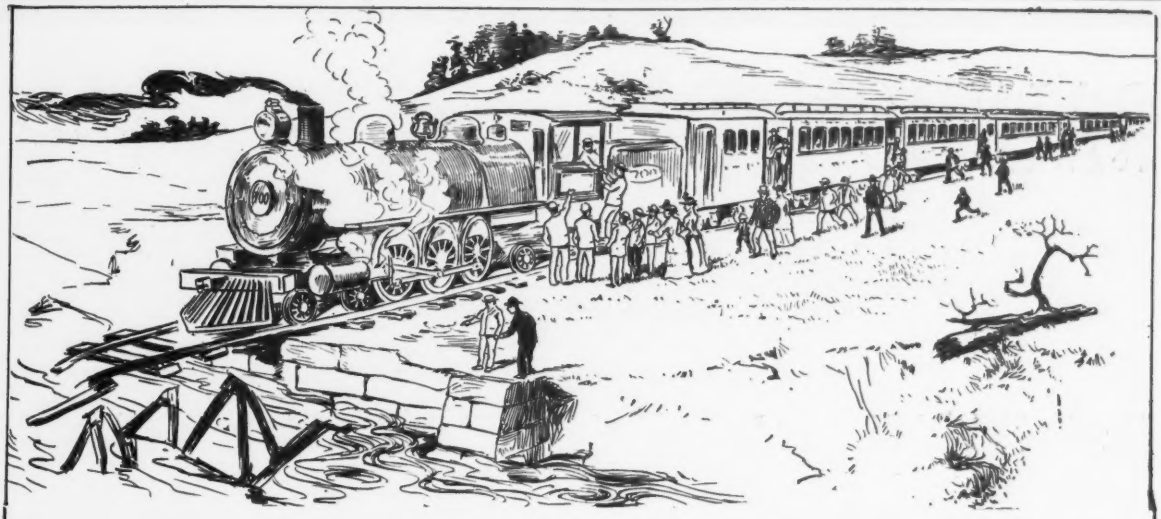

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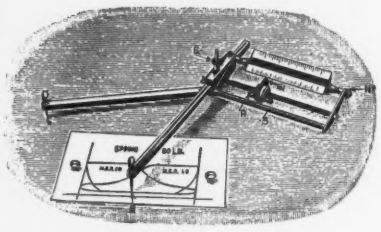

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The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power and to the interests of stationary engineers

VOL. VIII PHILADELPHIA, OCTOBER, 1904. No. 9.

The Electrical Production of Peat Coal in Norway.

By FRANK C. PERKINS.

The accompanying illustration, Fig. 1, shows the water power conduit, as well as the factory for manufacturing peat coal at Stangfjorden, Norway, by electricity. The illustration, Fig. 2, shows the turbines and generators at the power house at Stangfjorden, while the illustration, Fig. 3, and diagrams, Figs. 4 and 5, indicate the retorts and apparatus for the electrical manufacture of peat coal by the Jebsen system.

The electrical equipment of the generator room of the power house at this factory includes five dynamos having a total

Fig. 1.—Water Power Conduit for Peat Coal Plant, Norway.

capacity of 400 kilowatts. Five turbines are utilized, each directly connected to a six pole direct current machine, built by the Electrical Bureau of Christiania. These turbines have each an output of 128 horse power and operate under a head of 145 feet. The factory is 160 feet in length, 32 feet wide, and 25 feet high, and is constructed of iron, stone, and wood.

By means of the Jebsen process of producing peat coal by electricity, much of the waste of valuable by-products is avoided, and there is a great saving of creosote, paraffine and other valuable material usually wasted by other processes. In the Jebsen system, the peat is carbonized in air-tight retorts electrically, after it has been dried to a certain extent. It is claimed that this peat coal burns with very little ash, and with an intense heat, the peat produced by electrical means having a heating value of nearly 8000 calories. The analysis of this peat coal of Jebsen is said to contain more than 75 per cent. of carbon, the remaining 25 per cent. being nitrogen, hydrogen, oxygen and sulphur, together with a small proportion of ash and moisture. The peat coal produces very little soot, and it is claimed will largely take the place of coke, coal and charcoal, particularly where cleanliness is desired, and when it is wished to avoid evils produced by the presence of larger quantities of sulphur. The accompanying diagrams show the arrangements of the various buildings into which the peat passes during its manufacture into coal. In the storeroom it is kneaded and pressed into "strings" or "briquettes" which are 30 inches long, with a section 3 x 3 inches and weighing about five pounds. These briquettes then pass into a drying tunnel which is supplied with a hot blast from a blower in an adjoining room, the temperature ranging from 96 degrees F. to 212 degrees F. from one end of the drying room to the other. The briquettes then pass into an adjoining building by means of elevators and cars, and are charged into the retorts, which are about 3 feet in diameter and 6 feet high. The retorts are constructed of iron, and lined with an incombustible material, which is also a good insulator, and in which is embedded the resistance wire which produces the necessary heat for treating the peat, rheostats being provided for regulating the amount of current utilized. The retorts having their lids closed, are supplied with the necessary amount of current to carbonize the mass, and after a proper length of time has elapsed, the current is switched off, and the contents of the retorts falls into cars placed below, after it has cooled to a certain degree.

The peat is carbonized at a temperature of about 800 degrees F., and a special design of retorts has been worked out which will allow the process to be carried on continuously, the carbonized peat issuing at one end, while the mass to be treated is charged into the other end, the retorts in this case being con-

siderably longer. The gases given off by the peat while in the retorts are utilized for drying the raw peat. These gases are first mixed with a proper amount of cool air to produce a temperature of about 230 degrees F., and as large quantities of gas are obtained at high temperature from the retorts, there is an abundance of waste heat for drying the raw product. From the process of peat coal production by electricity as worked out by Jebsen, there is produced among the by-products 55 per cent. of paraffine, gas and coke each 4 per cent., and peat oil 35 per cent. After the paraffine "mass" has been crystallized

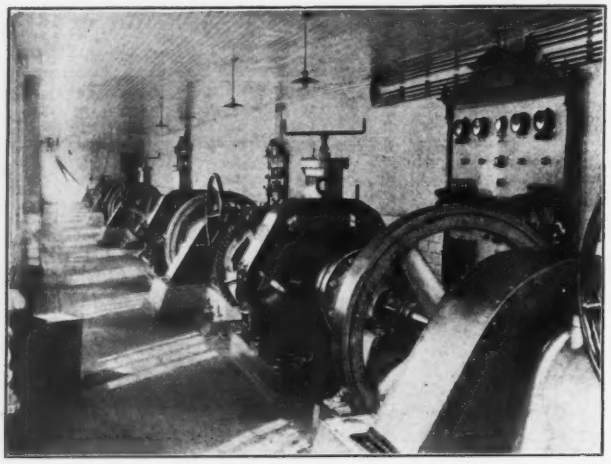


Fig. 2.—Turbines and Generators in Peat Coal Plant.

and has stood for a number of days, it is re-worked, giving 75 per cent. of filter oil, and about 25 per cent. of pure paraffine. The filter oil, with the peat oil, is disposed of as gas oil after extracting all of the creosote which is possible. From every 100 parts of air dried peat, there is about 4 per cent. of tar, from each 100 pounds of which there is produced about 10 pounds of paraffine. The peat coal is a very valuable product and sells at about $5.00 a ton, while the by-products are also a great source of income.

———o———

Commutator Troubles and their Remedy.

Sparking of the commutator at the brushes is the most general trouble experienced with a dynamo and motor and it has more causes than any other. In order to avoid it, the brushes must make good contact with the commutator, they must be true and have good contact surface and the commutator must be kept clean. Any collection of carbonized oil is sure to cause sparking. Lubricating the commutator with vaseline on a piece of canvas is advantageous.

On a bipolar machine, the brushes must be set diametrically opposite, on a four pole machine 90 degrees apart, etc. This condition must be attained while the machine is at rest, either by actual measurement or by counting the commutator bars between each brush. If the brushes of one set are not set properly, they may cover too much armature circumference and cause sparking.

The brushes must be set at the proper point. This is accomplished while the machine is in operation under its required load. The rocker arm, which carries all the brush holders, should be moved carefully back and forth until the point of minimum sparking is found. Sometimes there is quite an arc of movement in which sparking is not observed. The brushes should then be set at the centre of this arc, since heating occurs when the brushes are off the proper commutating point, even if sparks be not seen.

Sparking may also be due to fault in the commutator. A high commutator bar, a low bar, a flat, projecting mica, rough or grooved surface, eccentricity, or any condition of surface which causes the brushes to vibrate and lose contact with the commutator will surely cause sparking. If sparking be allowed to go on without correction, it will pit the commutator and make things worse. If the irregularity of the surface be slight, it may be cut down with sand paper held in a block which should be cut to fit the commutator. Emery paper should never be used. If the surface be very bad, it must be cut down with a machine. A small armature may be swung in a lathe; but a large one must be left in its own bearings and a tool held against the commutator by some special device. A perfectly true commutator may sometimes act eccentrically, because of the wear in the shaft bearings. New bearings will remedy this fault. If a coil in armature is short circuited, periodic sparking may result. The coil is likely to burn out if the machine is not stopped. The short circuit may occur from breakdown of the insulation within the armature, in which case rewinding is necessary; or it may be caused by metal chips or the like at or near the commutator, in which case the cause can be easily removed.

When a coil is broken, very violent sparking occurs, since half the armature current is broken every time the commutator bar connected to the broken coil passes from under the brush.

Fig. 3.—Group of Retorts for Carbonizing the Peat.

Such a break may occur within the armature, requiring rewinding, but it is more likely to occur where the coil end is attached to the commutator bar lug. If the break be at this place, the wire needs but to be secured or soldered to the lug and the machine is repaired.

In the above reasons, it is assumed that the machine is properly designed and of sufficient capacity to do the work it is called upon to perform, if not, sparking may be caused from other troubles, such as when the field of a motor is too weak,

excessive current flows and causes sparking, and, in this case, unless the defect is due to some mechanical defect of the field coils, rewinding of the fields is necessary.

The Most Powerful Locomotive in the World.

An engine which is unique both in design and size is exhibited at the St. Louis Exposition. It belongs to the Baltimore and Ohio Railroad and was built for them by the American Locomotive Works for pushing heavy trains on steep grades.

This engine, known as No. 2400, is by far the largest and

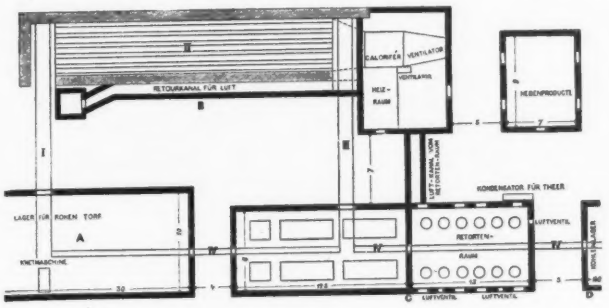


Fig. 4.—Ground Plan of the Peat Coal Power Plant.

most powerful ever built. According to American locomotive practice, it is somewhat unique, as nothing like it has ever been built in this country, although in Europe this type of engine is very prevalent.

The engine has twelve driving wheels arranged in two pairs of six, two high-pressure cylinders driving the forward set of wheels and two low-pressure cylinders driving the rear set of wheels. The cylinders of this engine are 20 and 32 inches in diameter with a 32-inch stroke. The driving wheels are 56 feet in diameter. The wheel base of the coupled wheels is 10 feet for each set, but the total wheel base of the engine is 30 feet, 8 inches. The high-pressure valves are of the piston type and the low-pressure cylinder valves are of the Allen-Richardson type. The boiler pressure is 235 pounds per square inch.

The valve gear on the engine is entirely on the outside of the drivers, a gear which is used extensively in Europe. It is so arranged that the engine can run with the cylinders compounded or high-pressure steam can be turned into the low cylinder in cases where great power is required. The valves are so arranged that either set of drivers can be run independently in case of an accident to one of them. The reversing gear and cut-off are regulated by compressed air apparatus.

The boiler has an internal diameter at the first ring of 6 feet, 10 inches. It contains 236 2¼-inch tubes, 21 feet long. The estimated heating surface of the tubes is 5366 square feet, and the firebox furnishes 220 square feet of heating surface, giving a total of 5586 square feet. The grate area is 72 square feet. The firebox, which is necessarily very large, is 108 inches long and 96 inches wide.

The total weight of this locomotive giant, in working order, is 150 tons, the weight of the tender being 64 tons. The coal capacity of the tender is 13 tons and the water capacity is 7000 gallons. All of the above weight of the engine is available for adhesion, as the engine does not have any leading, trailing or pony trucks.

Wireless Telegraphy in the War.

During the first few months of the war in the East between Russia and Japan, the readers of the London "Times" were treated to a comprehensive "wireless" report day by day of the naval operations carried on between the Japanese fleet and the ships defending Port Arthur. As the campaign became more involved, the "wireless" ship unfortunately received orders from the Japanese which virtually ended her usefulness.

The correspondent in charge of the boat has written a history of his three months of miracle work, which reveals the scope of Marconi's astounding discovery. After many difficulties, a pole 180 feet high was erected on shore, in a position where it was on neutral ground and in connection with the telegraph lines of the Orient. A boat was then secured and fitted out with the proper apparatus and the correspondent began cruising around about the various points of Japanese activity. From the moment the apparatus was completed, this boat, sailing in Chinese seas, was in constant touch with London; in fact, the talk between the correspondent and his London newspaper went on all the time.

The first bit of news picked up was considered so important that after it was sent across the waves, the correspondent hastened to the receiving station to see if it had been received. Another important message sent was a combat between torpedo boat destroyers off Port Arthur. This message, sent over one hundred miles, was scrutinized by the sender when his paper reached him one month later and it was found that it had reached the paper word for word just as he had dispatched it within sight of the combat.

Besides the sending and receiving of messages belonging to him, the corresponding would receive the messages constantly flying from Japanese and Russian posts and while these messages were in cipher, they gave information which was just as valuable. By the different sounds on the receiving key, he could tell the notes of the various ships; that is to say, he could tell if a Russian ship was at sea by listening for the answering communication from the shore. He could also detect whether the Japanese messages were being transmitted by relay to the naval base or whether the fleet itself was at sea. This

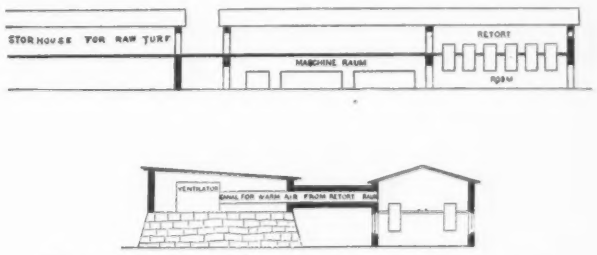


Fig. 5.—Elevation of Power Plant for Peat Coal Manufacture.

was of as much importance as if the messages themselves were understood, and during the time this "wireless" boat was in operation, their most successful news was obtained by listening for the wireless telegraphy of the opposing fleets.

It was unfortunate that the boat was suppressed, so that its enterprise had to be abandoned, for what was more thrilling than a ship, rolling and tossing in the trough of the sea, taking and sending from the winds as they pass, speech that a whole world was breathlessly waiting to hear.

THE ELECTRO-MAGNET.

Some Rules and Principles of this Ever-present and Important Device.

While the scientific world in general is acquainted with all the laws of the magnet and electro-magnet and its apparent peculiarities, the average person, however much he might be familiar with machinery and devices which contain this interesting piece of mechanism, has usually not given much thought to its fundamental laws of action. That it is an important device in the generation and utilization of the electric current need scarcely be mentioned. All one has to do is to look around and see what an important part it plays in the life of the world. It is the so-called "lines of induction," generated by the electro-magnets of a dynamo that make the electric current possible and it is this same principle which causes the motor to revolve with such power, the telephone to reproduce the voice, the telegraph to respond to the touch, the arc lamp to burn all night, the transformer to become almost a magician by changing volts and amperes into each other and a thousand and one other applications which can be thought of.

What is this device which plays such an important role in all electrical apparatus? It is a very simple arrangement of three things: an iron core, a coil of copper wire and an electric current. When the current is turned on, it flows around the iron core and magnetizes it and it is usually a magnet only so long as the current is turned on.

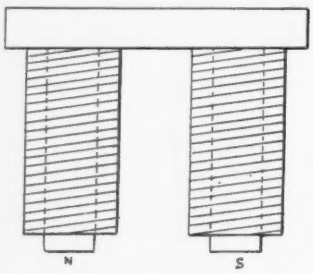
Magnets in general are known as permanent magnets and electro-magnets. The use of the former is practically limited, but there are many important features of the electro-magnet that can be best explained by the permanent magnet, as they both come under the same laws of magnetism.

Every magnet has two poles or ends, called the north pole and the south pole, named after the poles of the earth, because from the earliest days it has been known that the earth is a magnet and that a magnet needle, if mounted on a pivot so that it can swing at will, will point north and south. The north seeking point has therefore been called the north pole of the magnet and the other end, the south pole. By means of the magnetic needle, many laws of the magnet have been found. If a bar of iron that contains magnetism, and all iron does contain some magnetism to a greater or less extent, is held near the magnet needle, it is observed that one end is attracted by one end of the bar while the other end is repelled. If two magnetic needles are used, it is found that two of the ends will attract each other while the other ends will repel each other. From this is derived the first law of magnetism that "Like magnetic poles repel one another; unlike poles attract one another."

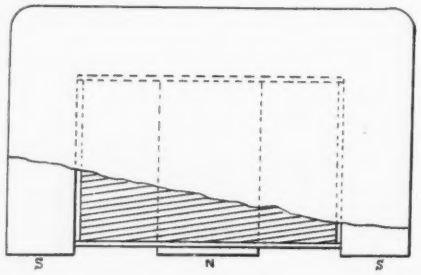
Among the other peculiarities of magnetism is that a magnet must have two poles; it cannot have one. If a magnetic bar be broken into two pieces, each piece will have two poles and possess the same properties as the larger piece and if the pieces are broken again and again, each piece must have a north and south pole.

It is found that by placing two magnets near each other, some will attract or repel each other with greater force than others. This is called magnetic force, and it gives the second law of magnetism: "The force exerted between two magnetic poles is proportional to the product of their strength, and is inversely proportional to the square of the distance between them." In other words, the stronger two magnets are, the greater is the magnetic force exerted and this force diminishes very rapidly as the distance between them is lengthened and increases very fast as the magnets approach each other. This can easily be illustrated by taking a magnet and placing it near a nail. At a certain distance the nail will not be in the least attracted by the magnet, but as the magnet is moved closer, the force becomes so great that the nail will suddenly move to the magnet and cling to it like an old friend.

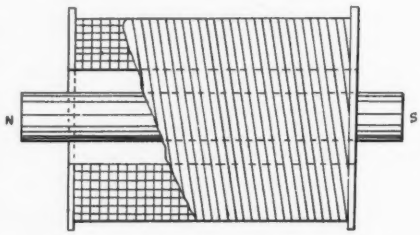
In speaking of magnets in general, it is assumed that they are made out of iron or steeel. The only other metals of importance that possess the power of magnetism are nickel and cobalt, but they are rarely if ever used.



Horseshoe Magnet.



Iron-Clad Magnet.



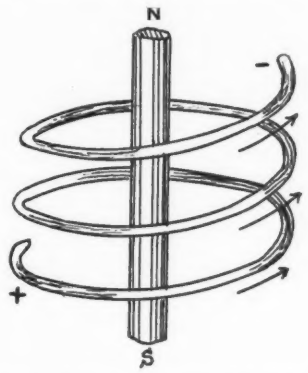
Coil and Plunger

Magnetism may be communicated from one piece of iron to another in two ways: by actual contact or by induction. It is this latter method of inducing magnetism that is the most important. A magnet is supposed to throw out around it a number of magnetic lines, and when a piece of iron comes within the range of those lines, it becomes a magnet by induction. The lines are called lines of induction and the stronger the magnet, the more lines of force per square inch it throws out. The strength of a magnet depends upon the kind of iron from which it is made. When a body possesses a high degree of magnetism, it is said to possess a high degree of permeability; that is, some irons are better conductors of lines of induction than others and the more permeable the iron, the higher it can be magnetized, and hence the greater magnetic force it is capable of exerting.

Not all magnetic substances retain their magnetism permanently. Hard steel retains the magnetism imparted to it, but cast iron and many impure qualities of wrought iron retain their magnetism imperfectly. This property of retaining its magnetism is called residual magnetism, so that steel would

be said to contain considerable residual magnetism, while very soft iron possesses very little residual magnetism.

Another method, and by far the one most widely used to produce magnetism, is the electric current and magnets produced by the electric current are therefore called electro-magnets. They are made in numerous forms, depending on the purpose to which they are to be put, the bar electro-magnet, the horse-shoe electro-magnet, the ironclad electro-magnet and the solenoid and plunger being familiar types. The polarity of an electro-magnet depends upon the direction in which the current is flowing around it. Various rules for remembering



Relation of Electric Current and Polarity.

the relation of the electric current and the magnetic force have been given. One of the best rules is that the direction of the current and the flow of the magnetic flux are related in the same way as the rotation and travel of a right-handed screw; that is, when the current travels around a bar in the direction a right-handed thread turns, the north pole would be represented by the point of the screw and the south pole by the head.

In any electro-magnet, the degree of magnetism depends upon the number of turns of wire, the strength of the current and the permeability of the iron. As the product of the number of turns and the amount of current is called ampere-turns, this can be simplified by saying that the magnetization depends upon the number of ampere-turns and the reluctance of the circuit, the term reluctance being used the same in a magnetic circuit as the term resistance is used in an electric circuit and the term permeability being very similar to conductivity. Certain kinds of iron have a certain permeability, so that if the number of ampere-turns on a magnet are known, the degree of magnetization is known. These are not proportional in the least but vary as follows: When there is no current passing around the core of an electro-magnet, it has very little magnetism and what it has is called residual magnetism. When the current is turned on, the degree of magnetization jumps very rapidly and as the current is increased, the magnetic field becomes stronger but nowhere in proportion to the first amount. As the current continues to be increased, this proportion grows less and less, until the amount of magnetism gained by increasing the current is very small. The iron is then said to be saturated; that is, no more lines of force can be crowded into a square inch economically. When the magnetizing current is removed, the iron loses its magnetism and becomes as before.

As the amount of magnetizing force depends upon the number of ampere-turns, it does not make any difference whether a small current with a large number of turns or a large current with a small number of turns be used; that is, 2000 turns of wire with 10 amperes passing through it will give the same degree of saturation to an iron core as 200 turns with 100 amperes, the product in each case being 20,000 ampere-turns.

In general, it can be stated that the laws of the magnetic circuit follow very closely the laws of the electric circuit and while Ohm's law is given as

$$\text{current} = \frac{\text{electromotive force}}{\text{resistance}}$$

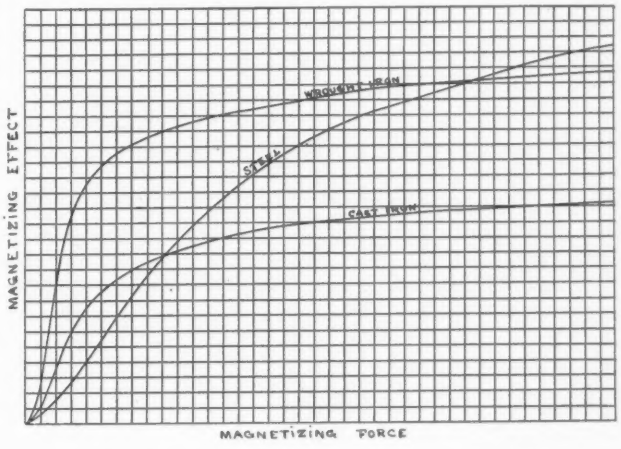
for the electric circuit the law of the magnet circuit is

$$\text{magnetic flux} = \frac{\text{magneto-motive force}}{\text{reluctance}}$$

magnetic flux being the amount of magnetization or magnetic current, the magneto-motive force being the number of ampere-turns creating the magnetic field and the reluctance depending upon the size, section, length and material of the iron cores and the magnetic circuit.

When an electric-magnet is used for lifting and pulling, such kinds as are used on cranes for lifting iron plates, the number of pounds that it can lift depends upon the square of the magnetic induction and the area of poles. It is therefore of necessity to have the iron highly magnetized and a large contact surface available in order to have the greatest lifting power. The strength of the magnet depends upon the kind of plate lifted and the kind of contact between the pole face and the plate. The plate in this case acts as an armature and except in a closed magnetic circuit, as a ring, the armature and its distance from the pole faces plays an important part in the reluctance of the magnetic circuit.

In a dynamo, the armature or field must revolve, so that there must necessarily be some air space between the poles and the armature. This air space adds materially to the size that the electro-magnets must be in order to drive the required magnetic flux through it. In the case of a dynamo, the lines



Relation of Magnetizing Force and Magnetizing Effect.

of magnetic force are not used for attracting the armature, the function of the poles being merely to provide a great number of these magnetic lines, the electromotive force of a dynamo being proportional to strength of the field, the number of conductors on the armature, and the speed of rotation. In a shunt dynamo, the voltage drops as the load goes on unless the current is increased to make the field stronger. In a series machine, the voltage increases as the load increases, so this prin-

ciple is taken advantage of in a compound machine for strengthening the electro-magnets, and hence the fields.

In the motor, the electro-magnets are used for creating a magnetic field which acts upon the currents flowing through the armature conductor so as to drag the armature around. Therefore, very powerful electro-magnets are used, so that a great torque can be produced without requiring much current in the armature.

When used with the electric telegraph, the electro-magnets attract an armature which emits audible sounds. When first used with the telephone, the speaker talked to an elastic plate of thin sheet iron, which vibrated and transmitted its every move to a similar plate in a similar telephone by electro-magnetic induction. As now used in the carbon transmitters, the vibrations of the voice change the resistance of the granulated coke placed behind the metal disc so that currents are set up in the circuit of the receiver, which is composed of a magnet and magnet coil. When the current is strong, due to the voice, it increases the magnetic field and draws the elastic plate toward it and when it is weak it causes it to recede, the electric coil on the permanent magnet tending to increase or decrease the magnetism. This sets in vibration the disc which throws the air into similar vibrations as the transmitting end, thus reproducing the sound. The mechanism of a arc lamp is adjusted by electro-magnets so that the carbons are kept always a certain distance apart as the carbon is consumed. In a transformer, the alternations of the current in the primary coil magnetize and demagnetize the iron core, which in turn sets up currents in the secondary coil in whatever ratio in respect to the voltage and current that is desired. A transformer is a closed electro-magnet, with two coils upon it. Usually the primary coil consists of many turns of fine wire to receive small currents at high pressure and the secondary, of a few turns of large wire to give out a large current at a low pressure. This combination can be reversed, in which case it is called a step-up transformer.

These are only a few of the many applications of the electro-magnet. Their design in each case depends upon the particular purpose for which it is to be used. In general, it may be said that when a very powerful attraction at very short distances is required, a short cylindrical magnet of the ironclad type is found to be best. To attract iron across a wide air gap which offers much reluctance, a horseshoe shape with long cores is used, as it requires a great number of ampere-turns to generate the necessary force to drive the magnetic flux across the gap. To give a gentle pull over a long range, a solenoid, or coil and plunger device is used. For giving a very quick-acting magnet, the coils are not wound all along the iron but only at the poles. As the tendency of a magnetic circuit is always to make itself shorter, the yoke and armature should form as nearly as possible a closed magnetic circuit.

The kind of pole tips, or pole shoe, used on an electro-magnet also depends on the purpose for which the magnet is to be used. On a dynamo, the pole shoes are put on the ends of the pole pieces to distribute the magnetic flux over a larger area in order that the lines of force between the poles and the armature will not be so concentrated, thus reducing the resistance of the magnetic circuit.

When used with alternating currents, the cores of the electro-magnets should be made of very thin plates or very small iron wires. The alternate rapid reversals of the magnetism in the magnetic field of an electro-magnet, when excited by alternating currents, set up so-called "eddy currents" in every piece of metal. The effect of these eddy currents in the iron is to heat it, which means loss of power. By subdividing the core into layers or laminations, the effect of the eddy currents is minimized, as the strength of this lost and useless current depends upon the thickness of the plates.

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STEAM TURBINES.

Comparison of the De Laval, Parsons and Curtis Types.

By R. T. Strohm.

PART II.

The steam is admitted to the Parsons turbine in the form of distinct and successive puffs. The duration of each puff is dependent upon the load under which the turbine is working. For a light load, the puffs are very short, thus admitting little steam, while for a heavy load, the puffs are longer, and consequently a greater steam volume is admitted. This peculiar form of admission is due to the governor arrangement, shown in Fig. 6. *A* is an eccentric rod, connected to an eccentric which derives its motion from the main shaft of the turbine. It is attached by a ball joint to the lever *B*, fulcrumed at *C*, The link *D* connects *B* with another lever *E*, whose fulcrum *F*, may be shifted up or down by the governor *G*; and the lever *E*, by means of other links and the fixed fulcrum *H*, is connected with the small relay valve *M*, whose motion from the mid-position shown will admit steam under the piston *N*, which is directly attached to the stem of the admission valve. It is evident that the reciprocating motion of the rod *A*, due to the eccentric, will be transmitted to the valve *M*, causing the port *P* to be opened in rapid succession. The result is that the piston *N* is alternately raised and lowered, thereby opening and closing the admission valve. As the governor increases or decreases its speed, the movable fulcrum *F* rises or falls, and thus the relay valve *M* is given a movement sufficient to raise the admission valve and hold it open just the proper length

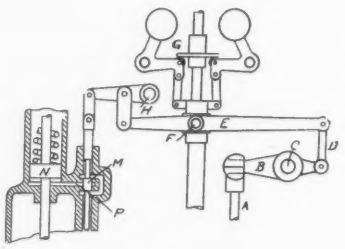


Fig. 6.

of time. Since the valve *M* is in mid-position when full steam volume is being admitted, any increase of speed or breaking of the governor parts would at once shut off the steam and prevent accidents. Another advantage claimed is that since the admission valve is always in motion, there is no chance for it to become inoperative through sticking.

The Parsons turbine has been largely used for driving electrical machinery by direct connection. This may be easily accomplished, since the rotative speed is not prohibitive. Single units of 5000 horse power have been successfully installed and operated. As originally built, the Parsons turbine was a hori-

zontal turbine, but recently a patent for a vertical Westinghouse-Parsons turbine was allowed. In principle, it does not differ from the horizontal turbine, but naturally the constructive details are far different. For example, the vertical shaft carrying the turbine wheels and the revolving generator field is sustained by a step bearing at its lower end, while, to relieve the bearing of some of the pressure which must naturally come upon it, the atmospheric pressure is employed to take up the weight of the rotating parts. This is effected by having the condenser chamber above the rotating drum carrying the vanes, and allowing the atmosphere to act under the drum.

The Curtis steam turbine is different from either of the foregoing types and yet resembles both. It is simply a combination of the principles of action of the De Laval and the Parsons. The steam is admitted into a series of nozzles in which a partial expansion takes place and from which the steam escapes into the first stage of the turbine. This first stage consists of three or four rows of moving buckets alternating with stationary vanes. After passing the first stage or group of wheels, the steam expands in a second series of nozzles which direct the flow into the second stage or group of turbine wheels. The same process is repeated, according to the number of stages through which the expansion is to be carried, which may vary from two to four. A sectional view of the valves, nozzles and blades in a two-stage turbine is shown in Fig. 7. It will be observed that as the expansion progresses and the volume increases, allowance is made by increasing the distance between the back of the blade and the front of the next blade, in succeeding rows. This is accomplished by reducing the thickness of the blades at the middle.

The Curtis turbine is of the vertical type, the turbine wheels and the revolving parts of the generator being fastened to a single vertical shaft having a step bearing at its lower end and a simple guide bearing at its upper end, to preserve the proper alignment. The stages of the turbine are separated from one another by cast-iron diaphragms, in which are valves which may be controlled by hand, but which are soon to be made automatic, so as to maintain a definite pressure ratio between the stages. For it is desirable to divide the whole load equally among the several stages.

The governing of the earlier types of this machine is accomplished by a centrifugal governor which operates the valves *a*, *a*, shown in Fig. 7, always keeping open a sufficient number to allow ingress of the proper amount of steam to carry the load on the turbine. The governing is not done directly by the governor, however; but instead, by means of an intervening mechanism. The governor itself is attached to the upper end of the main shaft, from whence it operates an electric controller. This controller governs the action of a number of electro-magnets, to each of which is attached a small pilot valve. These pilot valves in turn operate the valves *a*, *a*, in Fig 7, leading to the nozzles. Recent improvements, however, utilize direct mechanical movements for the operation of these valves, without the intervention of electro-magnets.

Considerable doubt was at first felt regarding the satisfactory running of the step bearing. Consequently all possible precautions for proper lubrication were made, using oil under pressure. In some cases, this pressure has accidentally been stopped, but the machines continued to operate without any apparent evil results. As this turbine makes from 500 to 750 revolutions per minute, it would seem that little trouble is to be expected from the step bearing.

As originally made, the buckets or vanes of the turbine wheels were integral with the wheels, being cut on their peripheries. More recently, however, the vanes have been made separately and afterward securely riveted to the wheels. It has even been found practicable to place two rows of blades on one turbine wheel, with sufficient space between, of course, to permit the insertion of a row of stationary blades.

To prevent accidents by reason of undue rotative speed, should the governor fail, a second centrifugal governor is used, which is connected to a butterfly valve in the main steam pipe. Upon reaching a speed which approaches the danger

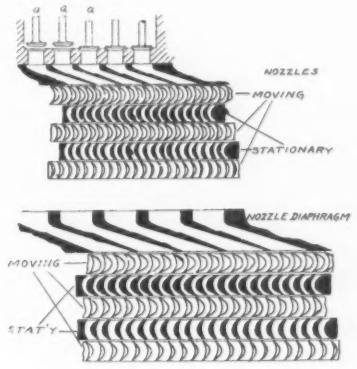


Fig. 7.

limit, the governor releases a weighted lever which closes the valve, thus preventing further supply of steam to the turbine.

A type of turbine which has come very much into evidence recently is that invented by Prof. Rateau of Paris, and built by a firm of French engineers. It is an action turbine utilizing the energy due to the velocity of the steam instead of that due to pressure. It is a horizontal turbine, differing from the Parsons in the fact that it is composed of a number of separate cells or chambers, each of which contains one turbine wheel. Fig. 8 will make the construction clear. In passing through the turbine, the steam first encounters the first row of distributing vanes *a*, *a*, by which the current is directed upon the movable vanes *b*, *b*. The diaphragms *c*, *c*, etc., are stationary, being held in grooves in the casing of the turbine. Thus each turbine wheel *d*, revolves in its own chamber. The turbine wheels are made of thin steel, the blades being riveted to the circumference, after which a band is riveted along the circumference formed by the outer tips of the blades, so as to preserve their correct spacing. These wheels are pressed into position on the shaft. Where the shaft passes through the stationary diaphragms, collars of anti-friction metal are used, shown at *e*, *e*.

The advantages claimed for this multicellular type of turbine are less waste of steam due to leakage, and a reduction of eddy currents with consequent friction loss. Take the Parsons type, as shown in Fig. 5. Note that there is a possibility of the leakage of steam past the outer ends of the revolving blades, as at *a*, or past the inner ends of the stationary blades, as at *b*. The steam leaking through in this manner would exert no useful effort upon the turbine wheels. In the case of the multicellular type, the only leakage which can occur is that

between the shaft and the ring of the anti-friction metal in the diaphragm. Since the diameter of the shaft is small as compared with the diameter of the turbine wheel, it may be easily seen that less leakage is apt to occur along the small circumference than along the latter.

In the first diaphragm of the Rateau turbine, the distributing vanes are placed in but a small portion of the circumference. In the second diaphragm, the number of distributing vanes is increased, until at the end, these vanes occupy the entire circumference of the last diaphragm. This is done because of the gradual increase of volume of the steam, due to its expansion. It must be evident that the steam does not pass through the turbine in a straight line parallel to the axis of the shaft. The rotation of the turbine wheels deflect it somewhat so that it takes a spiral, or helical course, like a screw thread. Therefore the distributing vanes in each diaphragm are set slightly ahead of those in the preceding ones, in order that the steam from one set of distributing vanes, upon passing through its wheel, may enter the succeeding distributer, instead of striking the blank wall of the next diaphragm. The radius of the wheels is also increased somewhat, in the successive stages, to accommodate the increased steam volume.

When compared with the reciprocating engine, there are many things in favor of the steam turbine. On the other hand,

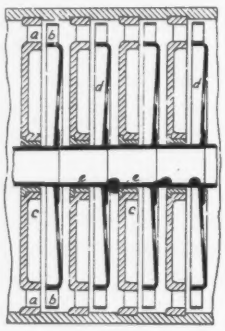


Fig. 8.

there are many advantages for the steam engine of the reciprocating type. It may not be amiss, therefore, to take up the relative advantages and disadvantages of these two classes of prime movers.

The steam turbine is under a constant torque, for any given load, since the impelling force acts at the same point and with unvarying intensity. There is no angularity of connecting rod to alter the turning effort. There is no reciprocating motion to set up vibrations, and hence heavy foundations may be dispensed with, the only requisite being that of strength and sufficient size. The turbine, on account of its rotative speed, develops a large amount of power per cubic foot of space occupied, and it is nowhere nearly as bulky as a reciprocating engine of equal power. It has a smaller number of rubbing parts and hence less friction loss on this account. There being no piston, cylinder lubricants are unnecessary, and the steam therefore is not contaminated with oil. The condensation may thus be returned to the boiler without necessity of filtration or separation. Superheated steam may be used without any danger to the working parts or to lubricants, since the former do not touch and the latter are not used.

Turning now to the possible disadvantages which might be asserted against the steam turbine, there is the wear on the blades, which is slight with dry or superheated steam, but considerable with wet steam. The economy depends very greatly upon the maintenance of a good vacuum, which may be rather difficult to observe continuously with long runs, taking into account natural wear and tear. Owing to the high rotative speeds, it is essential that an accurate balance be secured in the turbine, to prevent trouble in operation. Also, these high speeds unfit the turbine for application to many classes of work. The reversible turbine has not been much in evidence, yet there are numerous kinds of work which require the use of a reversible motor.

The reciprocating engine has established itself as a prime mover for any and all classes of work. The bulk of the world's power is developed by it. The range it covers is most extensive, and the steam turbine will need to be much changed and adapted before it can whollly drive the reciprocating out of existence.

Summing it all up, the losses in the steam turbine and in the reciprocating engine are of three classes. First, losses due to radiation of heat; second, losses due to the friction in the motor itself; and third, the loss due to the discharge of a large portion of the heat in the exhaust. With the steam turbine, the loss by radiation should be somewhat less than in the reciprocating engine of equal power. With regard to friction losses, the turbine should have by far the smaller amount, for the reason that it has a smaller number of wearing surfaces. The friction of the steam and the blades is so small as to be scarcely worth considering. Finally, the heat thrown away in the exhaust will depend largely upon the degree of vacuum obtained, and it would seem that here, again, the steam turbine would be the better. In other words, the steam turbine should show results considerably better than the reciprocating engine, under like conditions of pressure and service. It remains to be seen how nearly this has beeen accomplished.

Under the most favorable conditions, the steam turbine has shown a steam consumption of as low as 9 pounds per indicated horse power per hour. This was obtained by steam of 250 pounds pressure superheated 400°. Other tests, with less degrees of superheat, show consumption varying from 10 to 20 pounds per horse power per hour. The indicated horse power of the steam turbine is not obtained by indicator diagram. Instead, the brake horse power is observed, and a suitable mechanical efficiency assumed, or else the electrical output is recorded, and the combined efficiency of generator and turbine estimated. In a series of tests of a Parsons turbine using steam of 142 pounds pressure, 150° superheat and a vacuum averaging about 26.5 inches, the average steam consumption was about 19 pounds per kilowatt per hour, which would correspond to a consumption of 11 pounds, or slightly more, per indicated horse power per hour.

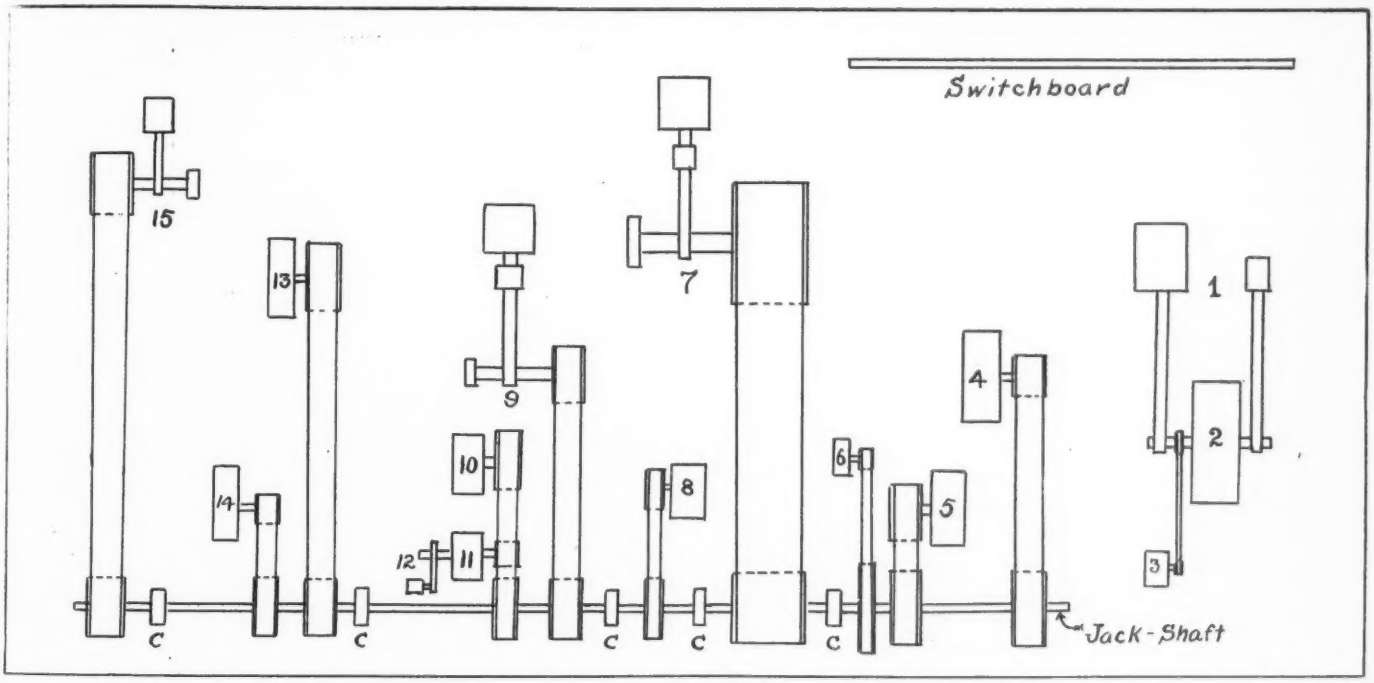
The reciprocating engine of the present day has in very rare instances given a steam consumption of as low as 11 pounds per horse power per hour. The general average will run considerably above this. Furthermore, the efficiency of the reciprocating engine falls off very rapidly when the load is reduced below the normal. In the case of the steam turbine, there is remarkably little difference between the steam consumption at full load and that for various degrees of underload. In this respect, at least, the steam turbine far outclasses the best performances of the steam engine.

A Modern Small Power House for Factory Uses.

By J. W. Himmelsbach.

Nearly every large manufacturing concern that employs methods that are anywhere near modern, usually generates its own power. The amount used may be large or small, but, eliminating the element of cost, it is easily seen that it is more satisfactory to generate power for oneself than to depend on that manufactured by someone else. The Stanley Electric Manufacturing Co., of Pittsfield, Mass., when working to its full capacity, can use about 700 horse power. To obtain this, they have their own power generating plant, a description of which is to be the subject of this article.

The power house is situated on the banks of a small lake, from which it draws its water supply, about a hundred yards from the factory, and is built of brick, one story high and a basement. The building is about 75′ x 100′ in size and consists of the boiler room and engine room on the ground floor, with feed pumps, condensers, etc., in the basement.



Floor Plan of Engine Room, Stanley Electric Co., Pittsfield, Mass.

To start at the beginning of things, steam is generated at a pressure of 135 lbs. per square inch in five 125 horse power horizontal, return tubular boilers. All boilers are hand-stoked, the coal supply being kept in bins just outside the boiler room, into which it is dumped from the cars, which run along an over-head trestle. Artificial draught is used throughout, this being supplied by Sturtevant blowers, which not only supply draught, but also take care of the stoke-hole, etc. The blower is driven by a small steam engine, which, in turn, is operated by a Spencer Automatic Damper Regulator. This regulator operates or controls the steam supply of the engine in such a manner that when the steam pressure in the boilers drops, the blower is started up, and of course, when the pressure reaches a predetermined limit, the steam supply to the blower engine is cut off. All water in the boilers is pumped from the lake mentioned above by two Worthington feed pumps, driven by two 12″ x 18″ x 24″ horizontal engines. From the pumps the water passes through two 500 horse power feed water heaters, from which it goes into the boilers. Besides the feed-water heaters and pumps, there are in the basement, two 500 horse power condensers, a vertical steam purifier and one 1000-gallon steam-driven fire pump; also two small drip pumps. The steam is fed from the boiler room to the engine room by three main steam pipes, which branch to supply the different engines.

The engine room is completely fitted out with modern machinery and appliances, the one glaring fault being the arrangement. A power plant arranged to run from a main jack-shaft can, in my opinion, never be relied upon. One not only runs the risk of an individual machine breaking down, which may happen in any station, but you also have the danger coming from a breakdown in your jack-shaft, which may cause a complete shut-down for a longer or shorter period of time. A long jack-shaft will always be a weak point in a station, no matter how cleverly it may be laid out.

The jack-shaft is driven by three engines, one MacIntosh-Seymour horizontal tandem compound, No. 7, in diagram, one Ball horizontal tandem compound, No. 9, and one single cylinder Ball, No. 15. The MacIntosh-Seymour engine is about 350 horse power, running at about 90 revolutions per minute, the driving pulley being 15 feet in diameter, with a 3-foot belt running over it. The two Ball engines are about 125 horse power each, operating at about 300 revolutions per minute. There is one direct-connected unit, No. 1, consisting of a 500 horse power MacIntosh-Seymour horizontal cross-compound engine and a 330 kilowatt, 2-phase, 2300 volt, 7200 alternations, Stanley inductor type generator, No. 2, running at 164 revolutions per minute. The engine has cylinders 16″ x 32″ x 30″. The exciter, No. 3, is belted directly to the generator

shaft and consists of a 10 kilowatt, 120 volt Northern Electric M'f'g Co. machine running at 850 revolutions per minute. The generator is equipped with S. K. C. separate phase regulating device, as are all 2-phase machines in the power house, mounted on the terminal board. On the shaft are placed ten demagnetizing coils, whose function is obvious. The whole unit rests on a foundation built up of brick and concrete, and runs with extreme smoothness and lack of vibration.

There are nine generators in all, which are belted to the jack-shaft. Referring to diagram again, No. 4 is an S. K. C. inductor type generator of 216 kilowatt capacity, 2-phase, running at 2400 volts, 16,000 alternations a minute and 666 revolutions per minute. No. 5 is a 267 horse power S. K. C. synchronous motor, used sometimes to help out the engines, and also as an emergency driver. It is a 2-phase motor, running at 2400 volts, 7200 alternations per minute and 600 revolutions per minute. The exciter used to magnetize the fields of the last two machines consists of a 10 kilowatt, 120 volt, 850 revolutions per minute, Northern exciter and is shown at No. 6. This much constitutes the first section of the jack-shaft, which is cut up into six sections by five Worrell friction clutches.

The next part of shaft is given up entirely to the MacIntosh-Seymour tandem compound engine. To make an insertion, I would say that the clutches are so arranged that the whole shaft can be driven from any one of the three engines or the synchronous motor, which gives a rather flexible, though awkward arrangement. No. 8 is a small Eddy direct-current generator, of the multipolar type, and will give 120 kilowatts at 225 volts and 600 revolutions per minute. No. 10 and No. 11 are two small S. K. C. 2-phase, inductor type generators, 2400 volts each, one running at 1000 revolutions per minute and 66 p. p. s., giving 100 kilowatts, and the other 90 kilowatts at 60 p. p. s. and 900 revolutions per minute. They are both excited from a small 4 kilowatt, 120 volt exciter, No. 12, belted to the 90 kilowatt machine. These three generators and the Ball tandem compound occupy the fourth section of the shaft. On the fifth section are a 200 kilowatt, 225 volt Northern D. C. generator, No. 13, running at 600 revolutions per minute and an S. K. C. inductor type generator, 3-phase, 2300 volts and 60 p. p. s., at 600 revolutions per minute, No. 14. The last section is given over entirely to the single cylinder Ball engine. This gives a total capacity, in generators, of 1466 kilowatts, or 1688 horse power, which, of course, is not all available at the same time on account of the boiler capacity; it is also not all required, about half being all that is ever used.

The switch-board, located as shown in diagram, was built by the Stanley Electric M'f'g Co., and consists of nine panels, as follows: One exciter panel, one D. C. panel, and seven A. C. panels, the total length being 32 feet. Each panel is made up of 4 slabs of 1¼" blue Vermont marble, 12", 15", 24", 27" wide respectively, with face polished and beveled. Each machine is equipped for running either in parallel or singly, and has a full equipment of voltmeters, ammeters, indicating and recording wattmeters, ground detectors and oil switches. The exciter panel is also equipped with a Tirrill voltage regulator. From the switch-board the power is transmitted over a pole line to the factory, where it is distributed for power and lighting purposes.

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The ordinary speed to run pumps is 100 feet per minute.

The Miner's Inch for Measuring Water.

The miner's inch, which is used extensively for measuring the flow of a stream of water, is the quantity of water which will flow from a vertical standard orifice one inch square when the head of water on the top of the orifice is 6 inches, as shown in Fig. 1. The mean value of a miner's inch is about 1.5 cubic feet per minute. The actual value differs considerably in different localities. In California, it ranges from 1.2 to 1.8 cubic feet per minute. In Montana, the customary method of measuring the amount of water purchased is through a vertical rectangle, one inch deep, with a head on the centre of the orifice of

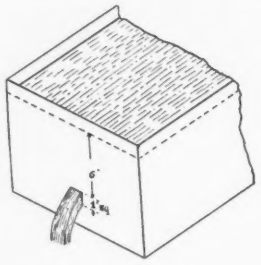

Fig. 1.

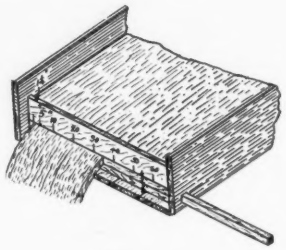

Fig. 2

4 inches, and the number of miner's inches is said to be the same as the number of linear inches in the rectangle; thus under the given head, an orifice one inch deep and 60 inches long would furnish 60 miner's inches.

Another common measurement is through an aperture 2 inches high and whatever length is required, and through a plank 1¼ inches thick, as shown in Fig. 2. The lower edge of the aperture should be 2 inches above the bottom of the measuring box, and the plank 5 inches high above the aperture, thus making a 6-inch head above the centre of the stream. Each square inch of this opening represents a miner's inch, which is equal to a flow of 1½ cubic feet per minute.

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Hardening and Tempering Steel for Permanent Magnets.

There are two ways of hardening steel for this purpose: (1), by suddenly cooling it from a bright red temperature; (2), by compressing it under hydraulic pressure while it cools slowly. If rods of steel are heated brilliantly red, and then quenched in water, oil or mercury, they become intensely brittle and glass hard. To temper hard steel it is then gradually reheated to a very dull red heat and softens slightly while acquiring a straw tint. If let down still further by continuing the reheating, it becomes a blue tint and is springy and flexible. Short bar magnets retain most magnetism if left glass hard without tempering, but magnets whose length is more than twenty times their thickness retain more magnetism if tempered down to a straw or even to a blue tint.

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Welding Instead of Riveting.

In the manufacture of boilers, combustion chambers and other similar apparatus, the use of welding threatens to supplant riveting, which has universally been used for joining the seams of metal work for these purposes. Some samples of welding for locomotive boilers and combustion chambers are shown at the St. Louis Exposition. These exhibits represent samples of welded combustion chambers similar to those

used on the steamer St. Louis, which are said to have been in service long enough to demonstrate their excellence, and a boiler ordered by the Southern Pacific Railroad. The welding process makes the boiler or other construction more expensive in the first place, but it is said to be economical in the long run owing to the greater life of the joint and the absence of the necessity for making frequent repairs.

Remedy for Burns and Scalds.

For slight burns, apply common baking soda (sodium bicarbonate) one tablespoonful to half a glass of water. Cover with clean cloth.

For severe burns, remove clothing by cutting away; if clothing sticks around burned part, wet with water or oil. When extensive, dress a little at a time; exclude air by covering surfaces. Never hold a burn to the heat. Remove patient to a cool place, apply sweet oil, olive or carron oil (equal parts of linseed oil and lime water), vaseline or white of an egg.

In absence of oils, dust burned parts with starch or flour. If nothing else is at hand, use moistened earth or clay.

If clothing catches on fire, throw person down, wrap him in a rug or shawl, roll him on the floor until flames are extinguished.

Burns from caustic lye or strong ammonia are treated by flooding the burn with water, then with vinegar, and then treat as if burned with fire.

Burns from acids are treated by flooding with water and washing with solution of baking soda.

Lime in the eyes is treated by flooding the eye with water and bathe with diluted vinegar or lemon juice.

Sun burns are covered with baking soda, vaseline or oil and bound with a cloth.

To cure frost bites, rub frozen parts with snow or bits of ice or put into cold baths. Afterward rub with cloth wet with warm water, whiskey or alcohol.

Refrigerating Machines.

Refrigerating machines are rated in two ways: First, refrigerating capacity, or cooling work that a machine will perform in 24 hours—one ton refrigeration being equal to the cooling work done by one ton of ice melting in 24 hours.

One pound of ice at 32° Fahrenheit in melting into water at 32 degrees will absorb 142 heat units, and 1 ton of 2000 pounds will consequently absorb $142 \times 2000 = 284{,}000$ heat units. One ton of refrigeration is therefore equal to 284,000 heat units in 24 hours, 11,833 heat units in one hour or 197 heat units in one minute.

Ice making capacity, or actual tons of ice the machine will make in one day of 24 hours is the second method of rating a machine.

In making artificial ice, the initial temperature of the water is generally about 72 degrees Fahrenheit. This water must first be cooled down to 32 degrees before freezing commences; to this must be added the temperature of the ice, which is the same as the brine bath, 15 to 20 degrees below the freezing point. Furthermore, there are losses from the exposure of the brine tank, ice cans, wastage in removing the ice from the cans, hence the actual number of pounds of ice manufactured is only about 50 to 60 per cent. of the refrigerating capacity of the machine.

Water.

In answer to a number of inquiries, the following data is given:

The weight of a United States gallon is 8 1-3 pounds, and contains 231 cubic inches.

The weight of a New York gallon is 8.00 pounds and contains 221.8 cubic inches.

An Imperial gallon weighs 10 pounds and contains 277.3 cubic inches.

A cubic foot of water weighs 62½ pounds and contains 1728 cubic inches, or 7½ gallons.

To find the pressure in pounds per square inch of a column of water: Multiply the height in feet by 0.434.

To find the height of a column of water, in feet, the pressure being known: Multiply the pressure shown on gauge by 2.304.

To find the capacity of a cylinder in gallons: Multiply the area of the cylinder in inches by the length of stroke in inches; divide this amount by 231, which is the cubical contents of one gallon, and the quotient is the capacity in gallons.

To find the quantity of water elevated in one minute, running the pump 100 feet of piston speed per minute: Square the diameter of the water cylinder and multiply by 4.

To find the horse power necessary to elevate water to a given height: Multiply the total weight of the column of water in pounds by the velocity in feet per minute and divide the product by 33,000—an allowance of 25 per cent. being added for friction, etc.

Well Pleased.

EDITOR THE PRACTICAL ENGINEER:

I feel I must congratulate you on the continued improvement of your paper "The Practical Engineer." In the September number I found things of interest on every page, including the advertisements.

I am very much interested in the troubles of "rodney gumkirk." It seems to me he has had about all kinds of trouble with his "masheen." I would advise him to have an extra "steem gaige" on hand in case the one he is now using starts leaking where it is "soddered." I hope he sends you those "rute beggars this faul" as I assure you they are good eating if properly prepared. With best wishes for you, I remain,

Yours very truly,

Yonkers Elec. Light and Power Co. W. H. MOORE.

Most for the Money.

Practical Engineer: I enclose money for renewal of my subscription herewith. I can't get along without "The Practical Engineer" and I don't think any other engineer can afford to for the price, for you give more good information for the money than any other paper.

Edinburg, Ind., Aug. 13, '04. W. G. ARVIN.

Would Rather Miss His Meals.

We have a letter under date of August 10th from Mr. A. H. Goff, Sanger, Texas, in which he says: "The August issue of your paper is chock full of good things for the practical engineer. I could not do without it, would rather miss two meals than miss one issue of 'The Practical Engineer.'"

The Practical Engineer

PUBLISHED ON THE FIRST OF EACH MONTH

L. L. RICE, Proprietor

46 North Twelfth Street Philadelphia, Pa.

The Practical Engineer is devoted to the economical generation and utilization of power for the industries.

Articles upon subjects of interest to engineers, will always receive our very careful attention.

The little things are often most valuable, therefore, we especially solicit short articles on the small problems met with in daily practice. When illustrations are desirable a pencil sketch is sufficient.

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The Use of Peat for Fuel. The value of peat as a fuel has probably been underestimated in this country, owing to the preponderance of other fuels, but the fact is that in a large part of Europe, it has had a widely-extended use for a number of years, especially near the places where it is found in abundance. Peat is the first stage in the formation of coal and is formed by the decomposition of vegetable matter in the presence of moisture, and for this reason is found in marshes and bogs. Because peat is seldom used in this country does not necessarily mean that it is not found in this country. It occurs in abundance in many parts of the United States, Alaska and the South American republics but its most extensive formation is in Canada and Newfoundland. In Europe, it is found most extensively in Great Britain, Ireland, Germany, Russia, Norway, Sweden, Finland and France and to a more or less extent in the other countries of Europe and Asia.

The usual mode of preparation is to cut it out of the bog in the form of a brick. These bricks are dried in the open air and are then ready for use. On account of its light and bulky nature, it cannot be conveyed a very great distance because of the cost of transportation. Efforts are now being made to render it more generally useful by eliminating the water and by drying it artificially and compressing it until its specific gravity is very near that of coal.

A description of a plant that produces commercial peat in Norway by the use of electricity will be found in another column of this issue. Up to within a few years, it has been generally thought that the conversion of peat into charcoal would not prove remunerative and many attempts to produce by-products from it, such as tar, paraffine, ammonia and oils, have been said to be unsucessful, but it is evident from the successful operation of this plant in Norway that these theories have been upset and that peat may yet come into more prominent use.

At the present time, this subject may not interest us very much, as in the older countries, where other fuel is scarce, but, as the scientists have forewarned us that they see the limit of our coal fields, it may be that peat will some day take the place of coal for fuel, as the price of this commodity is increased. Its advantage over coal is that it does not contain slate or any foreign substance to form clinker and is a smokeless steam producer. When burned in the form of briquettes, it gives out a long bright flame and leaves no soot or cinder and very little ash. The analysis of air-dried peat shows that in every 100 parts of dry peat, there are contained 58 parts of carbon, 6 parts of hydrogen, 31 parts of oxygen and 5 parts of ash, which give a heating value of 10,260 heat units, so that its heating value seems to measure up to the ordinary run of coal.

Water Power Plants. Since the successful harnessing of the waters of the Niagara, some years ago, the utilization of water power has gone on at a rapid rate, so rapid, in fact, that towns are now springing up with their accompanying manufacturing industries, near many of the power houses, where several years ago the wilderness reigned supreme. But when the town cannot come to the power house, the power house literally comes to them in the shape of the electric current.

One of these water power plants which has recently been put in operation is at York Haven, Pa., where the Susquehanna River is made to do the work of supplying the surrounding towns with heat, light and power. This plant attained some notoriety in the early months of this year by being almost swept away by the ice packs which gorged the river at that point; and so hardly a week passes by that some hydraulic plant is not heralded as having begun operations.

While, no doubt, many of these plants will be successful, it is probable that many of them will not be profitable from a financial point of view. After all is said and done, this is the underlying factor of any engineering enterprise which is built for the purpose of selling its power.

There are many factors that enter into the location of a water power plant other than the engineering difficulties which must be overcome. The expense of an undertaking of this

character is considerable and to make it a paying investment great care must be exercised in calculating what the income of such a plant will be. The operating expenses of a water-power plant are nearly constant compared to a steam plant. In the steam plant, the cost of coal used varies with the output but with the water power plant there is usually no such factor to consider. In a water power plant, the interest on the money invested, taxes, insurance and depreciation are the principal items involved, other than running expenses. While these factors enter, of course, into every plant, the fact that they are the most important things to consider makes it important that a plant of this kind should have a commercial output equal to the maximum capacity of the machinery, the variable cost depending on the load being very small.

The important feature of this problem is to obtain purchasers for the current produced and to sell it to them at a less cost than they can buy it elsewhere or produce it themselves. Many plants are depending on the future to make their operation profitable, it being hoped that the constant increase in the price of coal and freight rates will drive steam users to their locality. If this does not happen, there must necessarily be trouble ahead for many plants upon which fortunes have been spent and upon which an income on the money invested is looked for.

—o—

Superheaters.

The use of superheated steam in this country is of comparatively recent adoption, by far the larger number of experimental installations being built in European countries. Indeed, it appears that in the investigations touching upon the use of steam turbines, superheated steam, gas engines and producer gas, European engineers have always been first. American builders and engineers, however, though somewhat tardy in adopting these new ideas, have made rapid progress when they did begin to develop the schemes and plans of their trans-Atlantic brothers.

A number of serious obstacles beset the general introduction of superheaters into the field of steam engineering. In the first place, trouble was experienced with the valves and valve seats of steam engines, the trouble augmenting as the degree of superheat was increased. This was due to the difficulty of maintaining effective lubrication of the sliding surfaces. It was soon apparent, therefore, that the slide valve and the Corliss valve were not suited to the use of highly superheated steam. In European practice, it will be found that they have solved this problem by the use of poppet valves, the practice being almost universal, and this solution seems to be giving general and lasting satisfaction.

The lubrication of pistons and cylinders was also a point which necessitated attention and study. This, however, was not so serious a matter, inasmuch as heavy mineral oils with a high flashing point offered a remedy. This solution was doubtless deduced from gas engine practice, where we find the necessity of lubrication under high temperatures.

The question of the superheater itself caused as much worriment as all other causes combined, both as regards material and construction. In a superheater the conditions are very different from those in a steam boiler. On one side of the metal tube are the hot gases of a high temperature, and on the other side is steam of a much less temperature and of a considerably lower specific heat than water. As a result, the danger of burning the tubes is much greater than if they were filled with hot water, as in a water tube boiler. Owing to the high temperatures which may be attained, the matter of obtaining steam-tight joints demanded attention, since it was manifestly impossible to use joints of ordinary types packed with gaskets of materials which had been used with satisfaction in transmitting saturated steam. This point of difficulty has been overcome by arranging the superheater tubes in such a fashion as to remove the joints from the direct action of the flames or hot gases, and this is the method generally followed where cast iron pipes are used. It is possible to use either steel or wrought iron pipes also, and when these materials are employed, it is customary to use long pipes bent into coils, with joints removed to a safe distance from the hot gases.

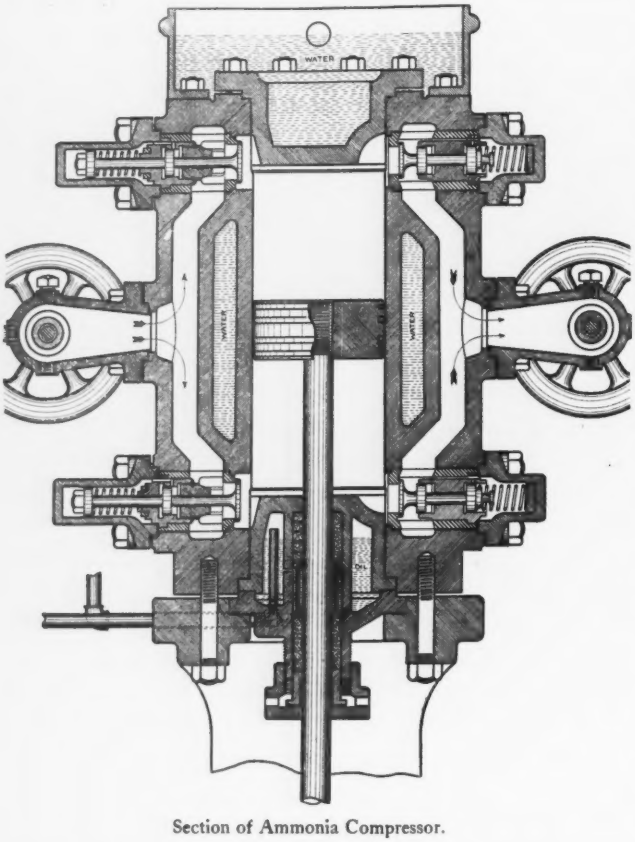
Cast iron is undoubtedly less affected by hot gases than eithe wrought iron or steel, since it will not soften so readily, nor i it easily attacked by sulphurous gases. But it must be made much thicker than a steel or wrought iron pipe of equal strength, and as a consequence it is not so efficient or rapid in its transmission of heat. The thinner tubes, on the other hand, will give a much better rate of heat transmission. All of these materials have been used in the construction of superheaters, and they have given satisfaction too, judging by installations which have been in operation for several years.

There are two methods of arranging the superheater. One is to place it in the path of the furnace gases inside the boiler setting and between the boiler outlet and the engine, so that the steam in passing from boiler to engine must go through it and be superheated by the gases from the boiler furnace. If the degree of superheat desired be moderate or low, the superheater may be placed so as to utilize the heat in the waste gases, after they have left the boiler, much as in the economizer. Where the superheat required is considerable, however, this will not answer, since the gases would not possess sufficient heat, at that point, to give the desired degree of superheat. It becomes necessary, then, to arrange the coils so that they are surrounded by hot gases direct from the furnace.

The other method of superheating is to place the superheater in a separate setting, with its own furnace. By this latter arrangement it is possible to regulate the degree of superheat as may be desired, a point which is not true of the other method.

Small Refrigerating Plant for a Candy Factory.

A candy factory seems at first thought to be the last place where a refrigerating plant would be needed, as the popular mind associates candy with heat, molasses, nuts and sugar, mixed together in various ways and with such delicious flavors as to make the biggest man wish he were a boy again, so that he could look in the white coated windows of the near-by candy store and with longing eyes wonder when he could for once have his fill. To the small boy, however, all candy is alike, but the manufacture of it is as different as there are different kinds and assortments. Some candies require a hot table on which they must be worked to get the proper consistency; other candies are cast in molds, while still others must be worked in a cool room. Some of the latter kind of candies that must be worked and dried in a cool room, are chocolates. The centres of these candies, composed of creams, jellies, marshmallows, etc., are first made separately and then coated with chocolate by hand. The chocolate is first mixed in kettles with the proper amount of sugar and heated by steam to the correct temperature. When the proper thickness and temperature of the chocolate have been reached, it is smeared over the waiting centres. If this were not done in a cool place and allowed to dry under a temperature of 70 degrees Fahrenheit, the result would be a candy that would be inferior to the taste and peculiar to the sight, the effect of drying chocolate in a warm place being to turn the chocolate white.



Section of Ammonia Compressor.

A candy factory, in which these principles have been applied, is the establishment of Henry Nuss & Co., of Philadelphia. It consists of a five-story building and basement. The basement contains the engine and boiler room, while the second floor contains the chocolate department where the refrigerating coils are placed.

The boiler room for this small plant contains a 75 horse power return tubular boiler. It is equipped with two-ball safety valves and self-closing gauge cocks. A Warren pump, 3″ x 2″ x 3″, is used for pumping the boiler feed, the supply coming from the city mains. The feed water is heated by a Berryman feed water heater of the closed type. The drips from all the piping in the building are returned to a tank through a Nason Steam Trap from where it is pumped with the feed water to the boilers. A 3″ x 2″ x 3″ Warren pump situated in the boiler room is also used for pumping water to the service tanks on top of the building. The boiler uses buckwheat anthracite coal, which is burned on herring-bone grates. In the boiler room the pipes are covered with magnesia-asbestos covering.

The engine room, which is 19 feet wide by 39 feet long, contains the engine and dynamo, ammonia compressor, switch-board, condenser coils, ammonia tank, oil receiver and receiver tank. The engine and dynamo are of the direct-connected type, an automatic high speed engine of 40 horse power driving a Quaker City dynamo of 30 kilowatt capacity. When running at a speed of 300 revolutions per minute, it is capable of generating 130 amperes at 220 volts. Above the engine there is a 4-gallon oil tank which supplies the engine with oil.

The refrigerating machine was built by the Buffalo Refrigerating Machine Co., and is of 6 tons capacity. It is of the double-acting vertical type, the engine and compressor being placed side by side, with the fly-wheel between them. The engine is of the slide valve type, the speed being controlled by a Waters adjustable speed governor with a safety stop arrangement for automatically stopping the machine in case the governor belt should break. The stuffing box of the compressor is arranged with an oil chamber, the oil being automatically supplied by a small oil tank bolted to the compressor frame. The lubrication of the cylinder and piston rod is entirely performed by this oil chamber, the quantity of oil being regulated by a valve on the oil tank. The oil chamber in the stuffing box keeps the packing lubricated and prevents leakage of gas through the stuffing box, as the chamber is connected in such a way to the oil tank and suction pipe of the compressor, that the pressure in the chamber can never exceed the suction pressure, and any leakage of gas from the cylinder through the bottom layer of packing will be drawn into the suction pipe of the compressor.

The switch-board is made of Tennessee marble and contains a Weston voltmeter, ammeter, a Wirt resistance box, two pilot lamps, two ground lamps and a double throw switch, so that the outside street current may be used in case of necessity, 150 ampere non-arcing fuses being interposed in the circuit.

The ammonia, after being compressed and its temperature reduced in the condenser, is expanded into coils, which are situated on the second floor, in the chocolate room. These coils are built in two sections, each of which is composed of 20-2 inch pipes, 20 feet long. The coils are enclosed and the cooling is done directly by blowing air against the pipes, allowing the outlets of the cold air to be placed where they are needed. This is done by placing the finished chocolates on racks and allowing the air to strike them, one-half hour being

sufficient to cool and harden them. The fan of the blower is run by a one horse power Diehl motor. A five horse power motor is required for the chocolate mixers and a 7½ horse power motor runs the freight elevator, both motors being of the Quaker City type. Besides supplying power for the three motors above-mentioned, the dynamo supplies the lighting

6 Ton Buffalo Ice Machine installed at the plant of Henry Nuss & Co., Phila.

throughout the building. The exhaust steam is used for heating the cooking apparatus and the building. The pipes of the ammonia plant are covered throughout with Nonpareil cork.

The freight elevator motor is started and stopped by an Automatic Switch Co.'s starter, which is worked from the car. This starter is driven by a belt from the motor and a powerful magnetic clutch operates the resistance arm. The clutch is energized only at the time of cutting out resistance and releases its hold on the resistance arm when the motor reaches full speed. The clutch magnet winding is connected in series with a small retaining magnet which it situated at the top of the resistance segments, the current to both the clutch magnet and retaining magnet passing through a dead resistance. When the resistance arm comes into contact with the retaining magnet, it short circuits the clutch magnet coil and releases the worm gear from any further work except the free revolution of the clutch. Mr. Louis Hartman is engineer of the plant.

Modern machinery has departed from the old fashioned colors of black, gray or maroon, and much of the new machinery is now colored in many bright hues, such as vermilion, and green, to suit the surroundings where it is placed.

Lignite in Nebraska and Dakota.

In the middle Missouri valley, many unsuccessful attempts have been made either to find coal or to develop a fuel supply from the lignites. Of the States in the western interior coal field, Nebraska alone shows no record of production. Recent investigations have shown that lignite does exist there which compares favorably with other fuels of the same class and of equal value with the widely-used brown coals of Texas and Arkansas which are used locally. The physical character of the lignite, however, offers a fatal objection to its use in more than very restricted areas. Its tendency to slack and disintegrate while drying, forbids its being handled or transported without great loss. Even if it could be satisfactorily delivered in neighboring cites at an advantageous price, especially constructed grates are necessary to its economical combustion whether it is used for domestic or steam purposes. Its immediate value in the area in which it occurs depends upon the cost of production, for this region is still well wooded and therefore provided with cheap fuel.

Plant at York Haven, Pa., put in Operation Successfully.

The large water-power electrical plant at York Haven, Pa., which was estimated to have cost $1,500,000 but upon which $2,000,000 has already been spent, was recently set in motion for the distribution of power.

This plant, it will be remembered, was last March badly damaged by ice, an account of which appeared in our April issue. This station is designed for twenty generators, each of 875 kilowatt capacity, at 2400 volts. Each generator is driven by two 79-inch turbine wheels and there are two 230 kilowatt exciters, each driven by a 62½-inch turbine wheel and each having sufficient capacity to excite the fields of the twenty generators.

All of this apparatus is placed on the main floor of the building. At the south end of the structure is a second story extending 70 feet north. In this spacious room are all the switchboard and measuring equipment for the plant, as well as machinery for the control of the water wheels.

Adjoining the generator station is a transformer house, or step-up station, where the current is raised from 2400 volts to 24,000 volts for transmission by overhead wires to the city of York, twelve miles away. Here there is a step-down transformer station, with full equipment of switch-boards, measuring instruments, lightning arresters, etc., where the voltage is reduced from 24,000 to 2400 for general distribution.

Beginning with the operation of the plant, the street car lines throughout the adjacent territory, electric lighting and power companies and many industries now derive their electrical current from the generators at this plant.

One of the latest electrical developments, which goes to show how rapidly this branch of engineering is progressing, is at Shawinigan Falls, Canada. A 50,000-volt current is carried a distance of 85 miles and develops in the neighborhood of 10,000 horse power. Four years ago, this locality was almost unknown, its only means of access being a canoe. Now, on account of its power riches, the City of Shawinigan is a rapidly-growing city of manufacturing industries.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Opening and Closing Valves.

EDITOR THE PRACTICAL ENGINEER:

I have read with interest the letters on valves and the care of the same by A. T. and by W. H. Wakeman.

I think A. T. is right regarding the way they should shut, as I have had quite a varied experience with valves in their different uses. I hardly think it fair for W. H. Wakeman to assume that from his wide experience his judgment should be unquestioned, as he put it forth in his article. Under the circumstances, I should be tempted to do as he has, but I would go a little further, as A. T. suggests, and try to remedy the defects, for such they must be.

There are nearly 400 valves in use where I am, ranging from ¼" to 8" and there are none that need a wrench to close them. Sometimes we need a wrench to start one but never to close one. I think most valves are ruined during the first week in use or the first few times they are closed. On steam lines, many times a new valve leaks, and if a wrench is used to stop that leak, it will have to be continually closed in that way to keep the valve tight. On the other hand, by waiting until the disc is hot, which generally makes it soft at first, and just seating the valve, as soon as the disc becomes hard, you will always have a nice working valve which will not leak, but if a wrench is used while the disc is soft, it presses it out so that when the disc is hard, a wrench is needed to press it to a seat.

As regards water valves, in my opinion, that is a subject that should be dealt with separately, as water always contains impurities, which corrode the valves to some extent, so that in many cases when the valve is not used very often, it is almost impossible to close the valve water tight that had seated perfectly before. I think the valve wheel of any valve large enough to close the valve under any ordinary circumstances.

If one could always handle his own valves, it would be all right, but the majority of men will screw down on a valve as hard as they can, then grit their teeth and try again, instead of using the small amount of gray matter, called brains, which they possess.

Longford Mills, Ont. E. C. S.

EDITOR THE PRACTICAL ENGINEER:

With interest I have read the controversy between A. T. and Mr. Wakeman about valves and their proper operation. A. T. in his first article, "As things are often done," speaks truly and well. No engineer should get offended at what he said. A valve when new should be of the best material and close perfectly when set with the hand wheel provided for that purpose. If it does not close that way, then something is wrong and I don't understand how the use of a wrench or any other leverage on the wheel can make it right. If the disc or seat has been injured by scale or sand, it should be refitted so it is again a valve and not a nuisance. If the material is at fault, discard the valve and be on the safe side. There is no material too good to put in steam appliances. Mr. Wakeman is right in his idea, but not for all time; only long enough to arrange for repairs, which should be done as soon as possible.

Many engineers are doing things that they should not do simply because they have never thought it wrong. They do it because they see others do it. I can show you a plant that has 100 valves and there is not a valve outside of the throttle valve that does not leak. These valves were all closed by force, some as small as ½" and ⅜" were closed with pipe wrenches. Mr. Wakeman is too rude in his criticism and he seems to be offended. I have always regarded articles written by him to be of much value, but his stand in regard to this has been a surprise to me and it does not seem possible he really means what he says. I hope not. I consider it a bad example; it encourages shiftless natures; it encourages men to buy worthless materials and in this way increases the possible danger therefrom.

Los Angeles, Cal. A. H.

As Things Are Often Done.

EDITOR THE PRACTICAL ENGINEER:

In a plant the writer had just taken charge of a few years ago, was a single Deane pump for boiler feed. This pump was not working as well as it might do, or as I should have liked to have had it, but nevertheless it was going, after a fashion. The employer came to the engine room to see me the first morning I was at work and mentioned the pump. He said: "We have had no end of trouble with that pump of late. I am afraid I will have to see about a new one. It is only about two years since that one was put in and it was a new one then. See if you can do anything with it. If not, I will order a new one of different make, for I don't want any more of that kind."

I told him that the pump ought not to wear out so soon if it was all right when bought new, and that I would examine it and see if I could determine what was the trouble. After the boss had gone out, I began to look about for some means to feed the boilers while I examined the pump. Finding I could afford to reduce the boiler pressure about 10 pounds, I fed the boilers with direct city pressure. I then began to look the pump over; first the water end and then the steam end, but could see nothing out of the way about it; only the steam end was in sore need of cylinder oil, for this pump had no sight-feed lubricator, nothing but the common old style cylinder cup and this had been sadly neglected so far as use went.

I was somewhat bothered as to what could be the real trouble. I finally made up my mind I would examine the packing on the valve rod and piston rod on both water and steam ends. I soon found the most of the trouble was right there, for it was packed in very hard, so hard that the pump could not move the valve stem as it should, and on the rods it was the same way, hard as iron.

When this pump was packed and a good supply of cylinder oil run in, it started off just as nice as any I had ever seen

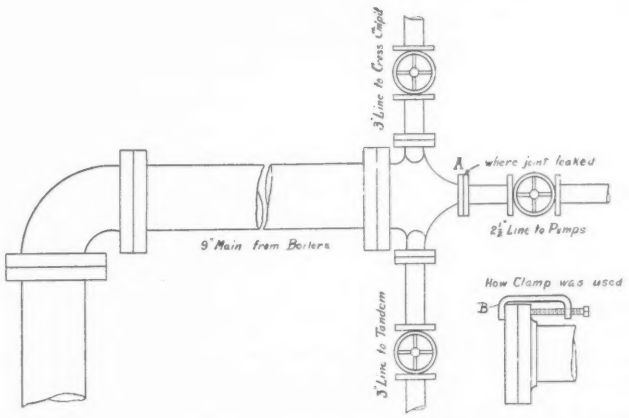
work. This was a case where the packing had been in so long as to be almost the cause of a new pump, just for the want of renewing. It is poor economy to allow packing to remain in too long, especially after it begins to get hard. My employer was more than pleased when he found the pump was all right. It is surprising to see how many depend on this old style of cylinder cup that is generally sent by the makers of a pump as a means of supplying cylinder oil to the valves and cylinder. Most of the persons in charge will fill them half full, instead of about full. I never could make one of them work by pouring oil in until they were level with the top. The proper thing to do is to put a sight feed lubricator on and regulate it to feed just the required amount of oil to properly lubricate the pump.

North Abington, Mass. A. T.

Emergency Repairs to Flange in Steam Line.

EDITOR THE PRACTICAL ENGINEER:

A few days ago the writer happened to go into the engine room of a friend, and on entering the door, the engineer was about to examine a leak in the main steam pipe from which the steam was blowing profusely. The engineer excused himself, saying he would get a ladder and take up the joint in a few minutes, and for me to wait. He got the 16 foot ladder, raised it against the main steam pipe near the leak, was soon up the ladder, and on examination said: "Oh! it's only a couple of loose bolts, I'll fix it in a minute!" He came down the ladder,



Emergency Repairs to a Flange.

got two solid wrenches and proceeded to try to tighten the nuts on the bolts. But he could not move them, either to tighten or loosen them. He called the fireman to help him and they could not move either nut, and when the engineer came down from the ladder he said that he thought he would have to shut down the entire plant to put two new bolts in the flange, for the nuts must be fired to the bolts. After talking over the matter with him, we came to the conclusion that we would make the repair without shutting down the entire plant; in fact, without stopping any of the engines, in the following way: The accompanying sketch shows at A where the bolts were loose on the flange, the C clamp at B shows how the clamp was applied between the bolts where they were loose. This clamp was made of 1" square tool steel and the screw was ½" diameter, cupped and case hardened.

In applying the clamp, the screw was tightened enough to prevent the joints leaking and then two large monkey wrenches were applied to the nut and bolt until they were twisted apart, this method being preferable to cutting the nut with a chisel, owing to the danger from the jar of the hammering. One bolt was taken out at a time and replaced with a new one and all the bolts were drawn up tight. The C clamp is one of the handiest tools in that engine room, so the engineer says. It plainly showns that the simple little tools in and about the engine room are, as a rule, the most needed.

Arkansaw, Wes.

How Should Valves be Connected on Steam Boilers?

EDITOR THE PRACTICAL ENGINEER:

This question is deserving of a large amount of consideration and thought, because the lives of engineers, boiler attendants and other persons depend upon this very important subject. The manner of connecting valves to a boiler where the pressure is under the valve is a practice to be condemned. The threads upon the valve stem are the only resistance against the load and the load is obviously the area of the valve multiplied by the pressure, consequently the threads on a six-inch valve, where one hundred pounds pressure is carried, must withstand a pressure of about 2800 pounds.

The lives of attendants as well as the lives of employees of a factory or people in the vicinity should be considered when valves are improperly connected, as the threads become worn out from constant use, leaving a possibility of having insufficient thread contact, which absolutely renders no factor of safety that they can resist. Accidents occasionally come to light where the danger of this method is employed and will continue until the insurance company or the law will pass upon it, thus alleviating this great danger, as above described. With a view of making my objections more plain, I herewith give the principal argument against connecting valves where the pressure is above the valve. It is claimed that in this way it is difficult to pack them. That is very true, but if valves are regularly packed when the boiler is shut down and not let go until they begin to leak or blow out steam, which is too often done, this difficulty would not take place. Another very important feature should not be overlooked. Intermediate valves should be placed in the line if properly piped, which necessitates an easy access for repairs, etc., which otherwise would be neglected. This question is of vital importance, especially where changes are to be made and when the steam fitter takes the job for so much. Unless there are specifications in the contract for him to follow in regard to proper piping, it is probable he would make it as profitable as possible regardless of the safety so necessarily desired. If the supervision of this class of work was left in charge of the engineer, he would undoubtedly see that the job was done properly, for his own safety as well as that of others, instead of leaving such responsibility in charge of steam fitters who introduce such methods of unreliable work. In the plant where I am employed, we are handicapped to some extent from occasional difficulties by not having any intermediate valves in our steam lines, which is the result of a steam fitter's contract under his own supervision. When we have occasion to do any repairs to the throttle valve of our engine, I am required to climb on top of the boilers and close the main stop valve of them all. I could enumerate many more

inconveniences of this kind which we have to contend with, but it appears that people will not be brought to their proper senses until the penalty is paid with the loss of life and limb.

Brooklyn, N. Y. J. G. SHERIDAN.

The Engineers We've Had.

No. 5.—THE UP-TO-DATE ENGINEER.

His engine runs quite noiseless, and you hear no pulleys squeak,
His belts do their full duty, and none of the steam pipes leak.
His firemen think quite well of him because he is not proud,
And does not brag of what he knows, or shout at them too loud.
He thanks them for suggestions when he undertakes a job,
And when they ask his help he's not afraid that he will rob
His store of knowledge, telling what admission means when late
Or early, for he is an engineer that's up-to-date.

His engine room's a model for its order and its looks,
And by the wall's a bookcase full of engineering books,
And he does not keep it locked, so that his firemen, when a chance
Occurs so they can study for a minute, can't advance.
Oh no! he loves, when steam is up and everything's all right,
To talk to them about the way to make their prospects bright,
And how to educate themselves and get ahead of fate.
They love to hear him talk to them, because he's up-to-date.

And when a job's in progress, and the others want to know
How large or small a thing must be to fit, he'll simply go
And get his pencil and his pad and figure it right out,
And that it's satisfactory, there's not the slightest doubt,
He's pleasant and he's modest, though he knows an awful pile,
But if you ask him tell how much, he'll say 'tis not worth while.
And to start up the machinery, we never found him late,
He's first on hand each morning, just because he's up-to-date.

The bosses like him greatly, and the workmen like him too,
And to help him out of trouble, almost anything they'd do,
Because his head is level, and he treats all with respect;
The man in rags is just as good to him as one well-dressed.
There is never any trouble and there's never any kick
About the way he does things, for he does them pretty slick.
He knows his business, you bet, we never have to wait
For anything, because our engineer is up-to-date.

Detroit, Mich. J. J. H.

Rodney's Troubles.
Or Do We Need a License Law in Michigan?

(Twelfth Letter.)

Mr. editur deer sur i hev bin thinkin about byen a gas olean injine and sellin mi thrasher injine to sum one, but when the fellar whut iz trien tu sell me the gas olean injine, wus explanin it tu me he got me all mixd up when he wuz tellin me and henry about the good points ov his meshene. he told henry that it wuz fule proof. now mr. editur whut duz fule proof mean i wud lik tu no, then he sed his mashene wus a 4 sikel tipe. whut duz thet meen, has a gas injine enny parts lik a bisickle? then he told me about the part whut he sed wuz the most important fetshure. thet wuz the egg niter. now mr editur pleeze tel me what a egg niter iz or wether the fellar wuz trien tu fule me or not. then he told me thet when hiz gas injine wuz runnin under a ful lode it woodn't uze neer az mutch gas olean az when it wuz runnin under a part ov a lode. this part i think iz a storry or a put on to cell hiz mashene, fur i no bettur fur when i thrash wimers otes it taiks 2 times az mutch kole to du their work az it duz to du lafe garners and wimers has 2 lodes of straw where garners hev onli a half a 1. so i think the gas injine man iz strechen things a bit and i kind o want u to tel me whut to du about the byen of sich a mashene. whut i meen iz du u think it wood pay me tu maik the change aftur i hav hed awl these yeers ov trubble with mi thrasher steem injine and jist got it whear i kan run it nisely and then jump into a nother biler of hot sudz or hed i bettur stik to the old stand bi.

i tell u i am a bit skiddish fur henry sez that gas or gas olean is a dangurus xplosive or sum thin like that, and he sez while u kant se the gas u kan smel it and ef u lite a match neer whear the gas is it will blo every thing tu smither enes, henry sez it is wurser than tien down the leever ov the safe ty valv a gud deal, so i dont want tu maik enny nu vensures with out first findin out sumthin about thu mashean. whear thu fellar told me about thu lecktrick part ov hiz gas injine i think i kud handel that al rite fur u no i hev had a gud chanse to lern about lecktrisity while i wuz around the villidge power house last winter. yes i a most furgot annuther thing about the gas injine, whut duz the wattur jaket du tu thu sillendur? i kant se whear it kan be enny gud fur when thu wattur got in mi sillendur it busted it. pleeze let me no az sune az u kin fur i want tu find out wethur a gas olean injine is bettur than mi thrashur injine.

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Just It.

Mr. Albert J. Girsting, St. Paul, Minn., writes under date of July 22nd: "'The Practical Engineer' is just it. It assists me more than anything yet published on engineering."

Will Help.

Practical Engineer: Enclosed find 50 cents for subscription. I am very well pleased with the paper and wish you every success. I shall be pleased to do all I can for its advancement.

Montreal, Canada, Jan. 20, '04. JAMES WILSON.

Worth Several Times Its Cost.

Chas. M. Fero, Bay City, Mich., writes: "I will say 'The Practical Engineer' is the best I have ever read, it is worth several times the amount you charge for it."

Running of Belts.

If two pulleys are out of line connected with a belt, one side of the belt must be tighter than the other. A question that has often been discussed is: Toward which side will the belt run? Some men say it will run toward the loose or slack side, but it will not. The belt runs toward the high or tight side, and it is for this reason that a belt will stay on a crowned pulley.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

EDITOR THE PRACTICAL ENGINEER:

I enclose my subscription for another year and I would be very much pleased if you would explain to me something in your next paper. I have made a rough sketch of our boilers and chimney. We have two horizontal return tubular boilers. No. 1 is 54 inches by 16 feet and has 40-3½ inch flues and No. 2 is 60 inches by 16 feet and has 44-4 inch flues. No. 1 boiler and chimney, as shown in the sketch, was used for some years and as it was too much for one boiler in the winter time, they put in No. 2 boiler. We run both boilers in winter and one in summer, but our chimney stayed the same and I do not think I have draught enough when I run both boilers. Do you think our chimney should be higher? If so, please explain to me how much higher it should be and also explain if there is any loss in fuel the way we are running and what difference there would be if the chimney would be higher. We are using the best screened lump coal.

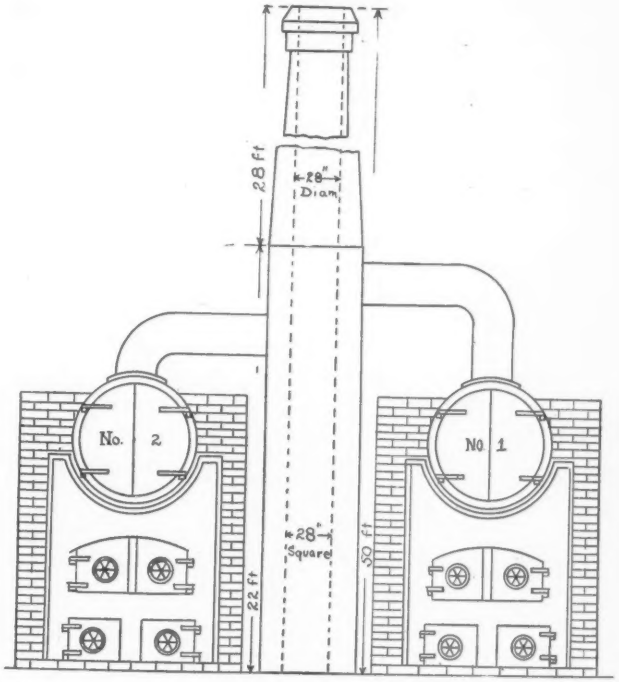
Milwaukee, Wis. F. K.

From the data of the boilers given, it appears that No. 1 boiler would have a rating of 55 horse power and No. 2 a rating of 65 horse power. By calculation, according to the well-known laws pertaining to chimneys, No. 1 should have a chimney area of 3.8 square feet, which is equivalent to an internal diameter of 27 inches, the height should be at least 60 feet. For No. 2 boiler, the diameter and height would be about the same, if each boiler was run separately. When both boilers run together, it is found that the area of the chimney should be about 5.5 square feet, or should have a diameter of 32 inches and the height of the chimney should be about 75 feet.

Comparing these dimensions with those given, it is found that while the chimney has sufficient area for each boiler, it has not enough area for both and the height is not sufficient to obtain the maximum horse power for each boiler separately, as from the sketch it appears that there is not more than 35 feet effective head to produce the required draft.

According to the above calculations, it would therefore be advisable not only to increase the height but the area of the chimney. If it is not practical to increase the diameter, then the chimney should be made higher than 75 feet to obtain the proper draft. If it is too expensive, or, for other reasons, it is not desirable to increase the height of the chimney, then forced or induced draft may be used when the size of chimney could remain as it is. With the arrangement of the flues as shown, it would be very easy to place a fan on top of the boiler and induce the draft through it on its way to the chimney.

There is no loss of fuel the way you are running, the principal objection being that the boiler is incapable of performing its full amount of work. The effect of increasing the draft is to increase the number of pounds of coal burned per square foot of grate surface and whether this state of affairs would be more economical than a slower draft would depend upon the kind of boiler and the condition of the heating surfaces. It can easily be seen that if these surfaces are covered with scale, the effect of an increased or forced coal consumption would be merely to raise the temperature of the flue gases, the heat of the coal going out of the chimney instead of being transferred to the water in the boiler. If the surfaces are clean and efficient, it is probable that up to a certain point, the increased coal consumption would show at least a corresponding water evaporation. Another factor that comes into consideration when speaking of increasing the draft, is the ratio of the amount of water the boiler contains to the surface available for heating. If the boiler is bulky and the heating surface is comparatively small, the effect of increasing the coal consumption



Is the Chimney large enough for these Boilers ?

would be to lower the efficiency of the boiler, as there is a time element involved, and instead of absorbing the heat as fast as it is generated in the fire box, the surplus heat goes up the chimney. We must, of course, allow a certain amount of heat to go up the chimney. This is inevitable, but there is a limit above which it is not economical to go. The temperature of the flue gases should not exceed 550 degrees Fahrenheit, and if it does, then the rate of combustion should be lowerd.

All of the above argument relates to obtaining the maximum efficiency from the boiler. There are times when circumstances are such that economy must be thrown to the winds. This always happens when at certain times or for certain reasons, the boilers must be forced beyond their rated horse power. On the other hand, many boilers are run below their rated

capacity, which may or may not affect their economy. The principal thing to consider is how to secure the maximum efficiency when running under normal conditions.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Please give me the rule for calculating the change gears of a turning lathe; for instance, required to cut a screw thread on a lathe that has an index plate not calling for same.

Middletown, Ohio. J. P.

If the motion of the lead screw of a lathe be carefully thought out, it is merely a matter of calculation and trial to find the required gears necessary to cut a certain thread. The change gears are interposed between the back end of the lathe spindle and the lead screw for the purpose of transferring motion to the apron, so that the cutting tool shall be moved through a definite pitch for each rotation of the cylinder or screw to be cut. Every turn of the lead screw moves the apron, and therefore the cutting tool, through a distance equal to its pitch and consequently, if the bar to be cut turns at the same rate as the lead screw, the pitch of the screw upon it will be the same as that of the lead screw. If it moves faster than the leading screw, the pitch will be less; and if slower, the pitch will be greater. It therefore follows that if we fit wheels on the lathe spindle and on the leading screw having the same number of teeth, the screw being cut will have the same pitch as the lead screw. If the gear on the spindle has a smaller number of teeth than the gear on the lead screw, the pitch of the screw to be cut will be small compared with the pitch of the lead screw.

From this it follows that when simple gears are used, the following rule applies:

$$\frac{\text{Pitch of screw to be cut}}{\text{Pitch of lead screw}} = \frac{\text{Teeth on lead screw gear}}{\text{Teeth on spindle gear}}$$

As the pitch of the lead screw is always known and the pitch of screw to be cut is known, it gives a ratio which must be filled by the number of teeth on the gears. For instance, if the lead screw has 6 threads per inch, the pitch is 1-6 of an inch and if the thread to be cut must have 10 threads per inch, then the pitch will be 1-10 of an inch. This gives a ratio of $10 \div 6$, which means that for every 10 teeth on the lead screw gear, the spindle gear must have six. Any two gears among those that are at hand may be selected, as a 20 and 12 tooth gear, or, 25 and 15, or, 30 and 18, or, 50 and 30, or whatever combination is desired or available.

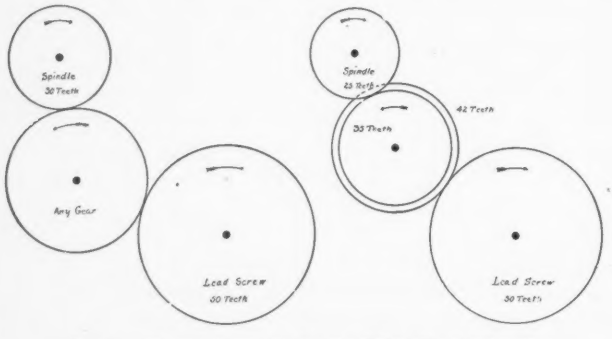


Fig. 1.—Change Gears for Cutting Right-Hand Threads.

The idler between the lead screw gear and the spindle gear may have any number of teeth, as its size does not affect the velocity ratio of the driving and driven gears. It only affects the direction of rotation of the screw to be cut. If the lead screw is a right handed screw and it is desired to cut a right handed thread, then one idler must be interposed, but if it is desired to cut a left handed thread, then two idlers would have to be introduced. The rule in general may be stated that if it is required to cut a thread having the same kind of thread as regards its being right or left handed, then an uneven number of axes must be used, and if it is required to cut a thread having a different direction of rotation, then an even number of axis must be used.

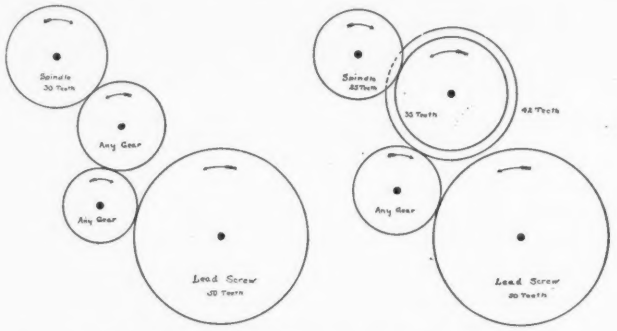


Fig. 2.—Change Gears for Cutting Left-Hand Threads.

The probable reason why the index plate does not call for the screw thread required to be cut is because the gears must be compounded, that is, there must be more than one gear placed on the axis of the idler. If in the above problem it is found that no two gears of those available will give a ratio of 10 to 6, then other combinations must be arranged to give it. For instance, if only such gears as those having 25, 35, 42 and 50 teeth can be used, they would be connected up by putting the 25 tooth wheel on the spindle driving the 35 tooth wheel on the idler. Connected on the same shaft with the idler a 42 tooth gear would be engaged with the 50 tooth gear on the lead screw. The accompanying sketch, Fig. 1, will show the arrangement of change wheels for cutting a right handed thread if the lead screw is right handed, and Fig. 2 will show the arrangement for cutting left hand threads with the gears selected.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Kindly answer the following questions:

(1). Will a small slide valve engine use more steam than a large one when under the same load? That is, will an engine 16 inches in diameter or 20 inches in diameter use the same amount of steam under the same load?

(2). Also, suppose you use 100 tons of coal this week and 150 tons of coal next week under the same conditions, what would be the cause of it?

Boston, Mass. F. H. R.

(1). It is impossible to say which engine would be the more economical, the 20-inch or the 16-inch engine. It would depend to a great extent upon the load on the engine. If the engines were lightly loaded, it is probable that the 16-inch engine would be the more economical on account of the fric-

tion load of the large engine being greater than that of the smaller engine. Cylinder condensation of the entering steam would also be a factor in determining the amount of steam consumed by the engine. With a slide valve engine, however, this would not be so prominent as in other types of engines, because the steam is throttled at small loads, giving a steam at admission whose quality is more or less superheated.

If the engines were heavily loaded, that is, suppose the 16-inch engine overloaded and the 20-inch engine full loaded, then the 20-inch engine would probably be the more economical if it was designed properly.

This could be explained by noting the indicator diagrams taken from both engines. As they are both slide valve engines of the same type, the smaller engine would cut off at about 5/8 stroke when heavily loaded, thus exhausting steam into the atmosphere, which steam could be used expansively in a larger cylinder. The larger engine would cut off earlier under the given load, thus making better use of the expansive properties of the steam, but having a large cylinder, the effect of cylinder condensation may be more seriously felt.

In general, it may be stated that the above question cannot be answered positively unless more facts and conditions be presented. With engines of good design, the smaller engine should work more economically at light loads and the larger engine should work more economically at heavy loads.

(2). If any plant uses 100 tons of coal one week and 150 tons the next week when doing the same work, there is a screw loose somewhere. Either the coal was not weighed properly or the work done was more in the one case than in the other. The only other way that this great divergence could be accounted for, would be a sudden leak, either in the boiler, the engine or the steam line. Examine the blow-off valve of the boiler, the valves of the engine and if these are tight, look for an open valve somewhere on the steam line. If these are tight, be sure of the coal consumption by weighing more accurately. This has often been found to be a source of the apparent inequality in coal consumption of power plants.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Will you kindly tell me how to make a dry battery for use with an electric bell, or gas engine?

New Orleans, La. T. R. S.

It would probably be cheaper to buy one of the many makes upon the market but if for other reasons it is desirable to make one, the following method is said to give a good battery of this kind:

First make a zinc cup, then roll a cup or tube of blotting paper, about three or four turns, to fit tight inside of the zinc cup, and pour in the bottom of the cup about two tablespoonfuls of hot melted pitch or rosin, to insulate the bottom of the cup. Next make the solution. This is done by dissolving five ounces of sal-ammoniac in one pint of clear water. When so dissolved, add seven ounces of granulated chloride of zinc. Stir thoroughly till dissolved, and continue stirring every few minutes for an hour or more. The solution is then ready for use.

The manner of making a negative or carbon element is to mix eight ounces of powdered black oxide of manganese and sixteen ounces of powdered carbon thoroughly together, and moisten with five fluid ounces of the solution. If the carbon and manganese are very dry, a little more solution may be needed. All that remains to complete the cell is to soak the blotting paper inside of the zinc cup thoroughly with the solution; fill the cup about three-quarters full and let it stand a couple of minutes; then pour out the solution, place the carbon plate in the centre of the zinc cup and pack in the carbon element good and hard. The packing will probably force a little of the solution up the paper by compression, but this will not injure the cell any. When the powdered elements are wet enough, clean away all the particles of the carbon elements from the top of the paper and zinc cup, so that there will not be any internal short circuit. Seal the cell, allowing the zinc and carbon connector to protrude and the cell is ready for use.

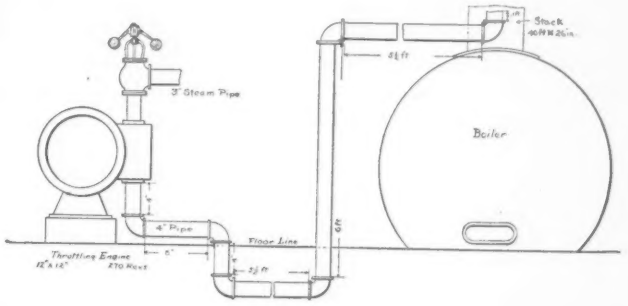
EDITOR THE PRACTICAL ENGINEER:

Being a subscriber to your paper, I have a question to ask.

What is the back pressure of the engine shown in the enclosed sketch, if it can be calculated, the boiler pressure being 100 pounds?

Clyde River, Nova Scotia. R. S.

The resistance to the flow of the steam depends upon the size of the exhaust, its length and number of bends and can be calculated according to the laws pertaining to the flow of water, only a different coefficient of friction must be used. This method is very complicated and when calculated, the results



What is the Back Pressure?

are at variance with practice, as the back pressure is somewhat reduced by radiation.

The back pressure could be best obtained from the indicator card or by placing a gauge on the exhaust pipe. In general, it might be said that all right angle bends, such as shown in the sketch, should be avoided, as the resistance of each right angle elbow is equivalent to a length of pipe about 40 times its diameter.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Will you please explain to me the following question in your next issue? If a boiler is tested at 60 pounds per square inch with cold water pressure, will this test be satisfactory to carry the same amount of steam pressure?

Pine Grove, Pa. T. O. Z.

There is no reason why a boiler tested under a water pressure should not be safe to run at the same steam pressure. In fact, this is a method often used to test boilers. It would be better, however, to test the boiler with water pressure

somewhat in excess of the steam pressure, as the steam pressure might be liable to fluctuate above the tested pressure and it is always well to be on the safe side.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions in the columns of the "Practical Engineer":

(1). At what temperature and pressure is air liquefied?

(2). Explain the reducing valve for reducing the steam pressure.

(3). Describe the mechanism of an electric transformer.

(4). What is meant by "torque"?

(5). What is meant by a "30-mesh" sieve?

(6). What is the difference between "make and break" and "jump" spark ignition in gas or gasoline engines?

Silver Creek, N. Y. H. W. B.

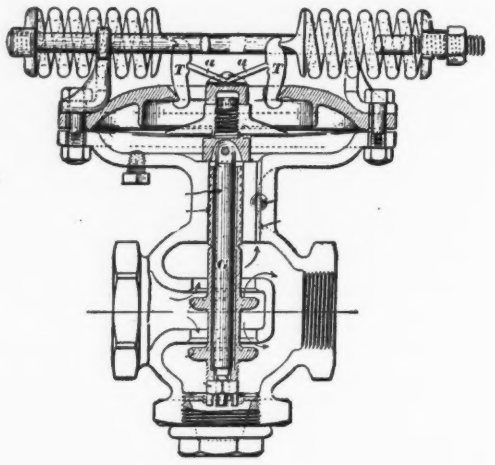
(1). The pressure and temperature at which air passes from a gas into a liquid is variable, just the same as the pressure and temperature of steam is variable; although, like steam, there is a critical temperature for every pressure when this transformation takes place. For instance, if the air was under a given pressure, it could be liquefied only by lowering the temperature to such a point which might be called the boiling point of air at that pressure. The earliest experimenters used pressures of 300 atmospheres and a temperature of 140 degrees below zero, but in the more modern methods only pressures which compress its volume 800 times are used. This requires a pressure of 1250 to 2000 pounds per square inch but the temperature is correspondingly reduced. This is done by compressing the air, then cooling it by a flowing body of water, then passing it through a long coil of pipes and expanding the cool compressed air by allowing it to escape through a valve into an expansion chamber, where its pressure falls from 1250 to 300 pounds, which produces a great degree of cold; then taking this very cold current of air back in reverse direction along the walls of the coil of pipes, and causing said returning cold air to further cool the air flowing from the compressor to the expansion tank, and finally delivering the cold return to the compressors and compressing it again, and so continuing the alternate compressing and cooling until the air condenses in liquid form.

On account of its very quick evaporation, liquid air is capable of producing the intense cold of 312 degrees below zero. So cold is this, that it will freeze mercury so that it can be used to drive nails. A beefsteak is frozen so hard at that temperature that it can be broken into a thousand pieces, its effect upon many other things being equally interesting.

(2). Reducing valves are used to obtain a pressure lower than that generated at the boiler. All reducing valves make use of the principle of throttling, which gives a lower steam pressure without any loss of heat. This throttling is performed by allowing the steam to escape from the boiler side of the valve to the engine side through a small opening which can usually be varied at pleasure to produce the required pressure, the smaller the opening the greater the reduction in steam pressure, and the larger the opening the less the reduction. There are several forms in general use, the Holt, the Mason and the Foster valves being examples. In the Holt valve, the low pressure steam acts on the lower side of a diaphragm and the weight which is on the end of a lever like a safety valve acts on the other and which may be set to give any desired pressure. The movement of this diaphragm causes a balance valve to move to and from its seat which regulates the size of the opening and therefore the amount of throttling or reduction. It is so arranged that the pressure in the steam pipe does not affect the movement of the valve. It depends only upon the pressure on the two sides of the diaphragm, which is the low pressure steam and the weight. In the Mason valve, a spring takes the place of the lever and weight. This spring can have its tension altered by a key. When the pressure in the low pressure side of the valve has risen to the required point, which is determined by the spring, the valve closes and no more steam is admitted until the pressure falls sufficiently to open the valve again.

In the Foster reducing valve, which is shown in the accompanying cut, the valve is held open by the spring and levers, until the steam pressure at the exit presses on the diaphragm sufficiently to close the valve. It consists of a balanced throttle valve on a stem G, the position of whose discs is regulated by a coil spring, which is in turn connected to a diaphragm through a series of toggles, *a*, *a*, and levers T, T. The steam on the low pressure side of the valve acts on the diaphragm, which determines the opening of the valve, through the series of levers shown. The steam, in passing through the valve, is thus throttled or wire-drawn and so reduced to the desired pressure. This pressure can be varied by changing the tension of the spring, but when the spring is once set for a certain pressure, that pressure is constantly and automatically maintained on the outlet side of the valve.

(3). The word "torque" is often used in place of the words "twisting moment." It is used extensively in electrical practice when speaking of the power of a motor, the two factors of its mechanical rotative power being its "torque" and speed. If the field of the motor is maintained constant, the "torque" is proportional to the current in the armature, the speed being proportional to the voltage.



Foster Reducing Valve.

(4). A "30-mesh sieve" means that there are thirty openings in the sieve for every inch of length or width.

(5). When the "jump" spark is used for gas or gasoline engines, the arrangement for producing it consists of two electrodes insulated from each other. These are placed in the end

of the cylinder at a small distance from each other. The secondary circuit of an induction coil is connected to these electrodes. In series with the battery and primary circuit of the induction coil is placed a contact operated by the engine, which makes circuit and breaks it at the moment ignition takes place. The spark "jumps" across the gap between the two electrodes and causes the gas to unit. This is known as the "jump spark." In the "make and break" spark igniter, one electrode is fixed and the other moves so as to come into contact with it at the proper time. A battery and spark coil are connected in series with the two electrodes. This kind of a spark is known as the "make and break" spark.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Will you be so kind as to give the rule and example to find the horse power of the following pump?

It is a duplex pump of size 6" x 6" x 6"; each cylinder is running at the piston speed of 30 feet per minute, with a boiler pressure of 90 pounds. This pump is connected to a 4-inch driven well, 109 feet, but has only about 6 feet lift and discharges through a 3-inch pipe into an open tank upon the roof 60 feet above the pump.

I also wish to state that this pump don't work to my satisfaction. It will not run with less than 50 pounds of steam pressure. Can you give me the cause for this? I think it is because the steam cylinder is the same size as the water cylinder and I believe the steam cylinder should be larger in order to overcome the pressure of water on the water piston.

Vineland, N. J. F. M.

The horse power that a pump is giving out can be obtained by multiplying the number of pounds of water that is lifted in one minute by the height of the lift in feet and the result divided by 33,000. In the given problem, the pump cylinder is 6" x 6" and moves at the rate of 30 feet per minute, which is equivalent to 60 strokes per minute, the lift being 66 feet. The area of the pump cylinder is 28.274 square inches, which is equivalent to 0.196 square feet. In one minute the cylinder displaces $0.196 \times 30 = 5.88$ cubic feet of water. As the weight of a cubic foot of water is 62.5 pounds, this is equivalent to 367.5 pounds raised in one minute. The lift being 66 feet, $66 \times 367.5 = 24{,}255$ foot pounds per minute for each cylinder, or, 48,510 foot pounds for both cylinders, it being a duplex pump. Dividing by 33,000, the number of foot pounds in one minute, the horse power that the pump gives out working under the given condition will be $48{,}510 \div 33{,}000 = 1.45$ horse power. As the efficiency of a small pump is about 60 per cent., it would require 2.42 horse power input to get the desired power.

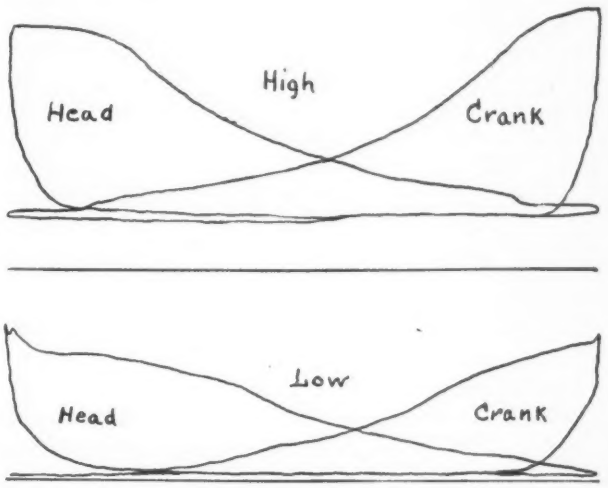
This can be worked out approximately from the steam end. If there is a pressure of 50 pounds on the piston and the area of the piston is 28.27 square inches, the total steam pressure will be $28.27 \times 50 = 1413.5$ pounds and this multiplied by 30 feet per minute will give $1413.5 \times 30 = 42{,}405$ foot pounds, or 84,810 foot pounds for both cylinders. Dividing by 33,000, this gives the horse power of the steam cylinders as $84{,}810 \div 33{,}000 = 2.67$ horse power, or an efficiency of $1.45 \div 2.67 =$ 54 per cent. This loss of power is due to various reasons, such as the losses in the pump incurred by the friction of the moving parts, friction of the water in the piping, etc., and it is for these reasons that a steam cylinder must be larger than the water cylinder in order that the pump will be able to pump against its steam pressure, assuming, of course, that they both have the same stroke, which is the usual arrangement.

If the pump does not have to pump against as high a pressure per square inch as is used in the steam cylinder, then it is a matter of design as to just how large the water cylinder should be to do the required work. For instance, in a pump that works under a steam pressure of 100 pounds per square inch, it would not require a water cylinder of such a large diameter as the steam cylinder to do the required work if the water head pumped against was equivalent to only 10 pounds per square inch. On the other hand, if the water pressure pumped against was 200 pounds per square inch, then the water cylinder must be considerably less in diameter than the steam cylinder, if the steam cylinder works under a pressure of 100 pounds per square inch.

The pump above-mentioned would therefore work better under the given conditions if the diameter of the steam cylinder was larger or if the steam pressure was increased.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Enclosed please find high and low pressure diagrams of a tandem compound Harrisburg four-valve engine 14½" x 28" x 18". When the cards were taken the engine was running at 200 revolutions, with 140 pounds boiler pressure. The indicator springs used for taking the high and low pressure diagrams were 80 pounds and 20 pounds respectively. Will you



Is the Work equally divided?

kindly tell me the horse power of the engine and how the work is divided between the cylinders?

Phila., Pa. C. P.

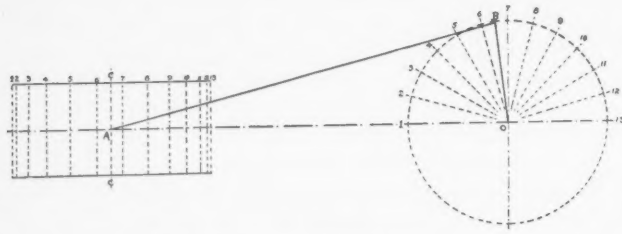
Upon calculation, the horse power of the head and crank ends of each cylinder was found as follows: High pressure head end, 59.0; high pressure crank end, 56.3; low pressure head end, 41.6; low pressure crank end, 28.7. This gives the horse power of the engine as 185.6 with the high pressure cylinder doing 115.3 horse power and the low 70.3 horse power. —[Ed.]

EDITOR THE PRACTICAL ENGINEER:

I was told by an experienced engineer that when the piston of a Corliss engine has travelled exactly one-half of its forward stroke, the centre line of the crank is not at right angles with the connecting rod. Please tell me if he was right or not, and if he was, give me the reason and oblige a constant reader.

Los Angeles, Cal. P. B. M.

Your engineer friend informed you correctly. The reason that the connecting rod is not at right angles to the centre line



Relative Movements of Crank and Piston.

of the crank when the piston has travelled exactly one-half of its stroke is due to the so-called "angularity of the connecting rod." The accompanying sketch will illustrate this more clearly.

The radii of the circle, 1, 2, 3, 4, etc., show the different positions of crank for every 15 degrees travelled in the revolution. OB represents the position of the crank when the piston has travelled exactly one-half of the stroke. AB represents the position of the connecting rod at that moment. The lines 1, 2, 3, 4, etc., represent the position of the cross-head when the crank is occupying positions 1, 2, 3, 4, etc. It can be seen from the sketch that when the crank has moved 90 degrees, the piston has moved more than half its stroke.

It is on account of these varying positions, depending on the ratio of the length of the crank to the connecting rod, that the position of the crank OB is not at right angles to the connecting rod AB. To prove this, divide the distance AO in half and with that point as a centre and ½ AO as the radius, describe an arc. If the angle ABO is a right angle, the arc will pass through the point. This it fails to do with any construction, so that the angle ABO is not a right angle.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions:

(1). What is the horse power of an engine with a cylinder 2" x 6 ⅛" of the Corliss type, running at 50 revolutions per minute, with a boiler pressure of 30 pounds? The piston takes up one inch of the bore, which leaves 5 inches stroke, allowing 1-16 of an inch on each end for clearance; cut-off takes place at ¼ stroke.

(2). Also state what would be the horse power of the same engine running at the same speed with the same cut-off, with 50 pounds boiler pressure, and what would be the proper size for steam ports and exhaust ports? How much lap and lead should be given this engine? Is 1-16 of an inch too much clearance?

(3). How much pressure should be carried on the low pressure cylinder of a cross compound engine? What is the amount of work it can do if the engine is non-condensing and running with 150 pounds boiler pressure, and what will be the amount of work if the engine is condensing with 24 inches of vacuum?

(4). Can a pump lift hot water? If not, explain why.

(5). If a locomotive is built for speed, does the builder have to decrease the power in order to get the speed, or can a very powerful locomotive be built for high speed?

Seigfried, Pa. H. N. C.

(1). As has often been said in these columns, there is no way of accurately determining the horse power of an engine except from an indicator card, so that results calculated from the dimensions of the engine are only more or less approximate. Using the well known horse power formula, we have,

$$\text{H. P.} = \frac{\text{PLAN}}{33{,}000}$$ in which L = 5 inches, or .416 feet, A = 3.14 square inches and N = 100. Everything is known except the mean effective pressure. With an engine cutting off at ¼ stroke, the mean effective pressure is usually about .55 of the initial pressure, which would make P = 16.5. The horse power would then be

$$\text{H. P.} = \frac{16.5 \times .416 \times 3.14 \times 100}{33{,}000}$$

or .065 horse power, a very small power indeed.

(2). The horse power of this engine when running at 50 pounds pressure would be .11 horse power. The area of the steam port can be obtained by multiplying the area of the piston in square feet by the stroke in feet and by the number of strokes per minute and dividing by 5000, the allowable speed of steam per minute. The result will be the area of the port in square feet. In this problem, it gives the area of the ports as .026 square inches. The exhaust ports are usually made about one-sixth larger than the steam ports. Without going into the problem of valve setting, 1-16" of an inch should be sufficient lap, while the lead would be practically nothing. A 1-16 of an inch is not much clearance, as allowance must be made for the roughness of castings and the wear to be taken up by the cross-head and crank-pin boxes.

(3). The pressures in a low pressure cylinder of a non-condensing engine are usually about one-third of that of the high. If an engine is designed properly it is usual to expect the high pressure cylinder and the low pressure cylinder to divide the work, whether the engine is condensing or non-condensing.

(4). A pump cannot lift hot water successfully because as the plunger of the pump moves back and forth, it creates a partial vacuum in the suction pipe. This will cause the hot water to evaporate and the pump cylinder will be filled with steam and vapor instead of with water, thus destroying its suction qualities.

(5). The indicated horse power of an engine increases as the speed increases, so that it is necessary to build a powerful locomotive to run at high speed. The power of an engine depends upon the average pressure in the cylinder and while the train resistance increases as the speed increases, this pressure decreases as the speed increases because of the higher piston speed and more rapid valve travel. Increasing the boiler capacity and pressure has been the common way of increasing the power of the locomotive.—[Ed.]

The Patterson-Berryman Feed-Water Heater.

The use of exhaust steam for heating purposes is now so universal and its advantages are so numerous and well known, that it would be superfluous to mention them, and yet, there are many boiler plants that do not make use of this important property of exhaust steam. A boiler plant without a feed-water heater is a most wasteful arrangement and as the price of fuel saved by their erection is often many times the cost, besides other important advantages, their installation is almost imperative.

The Patterson-Berryman feed-water heater, manufactured by Frank L. Patterson, 24 Cortlandt St., New York, possesses all the up-to-date features demanded of this type of apparatus. It consists of a cast-iron shell and settling chamber and a nest of seamless brass tubes, both ends of which are expanded into an extra thick cast-iron tube plate. The water passes through an entire row, or bank of tubes at once, thus circulating through

Patterson-Berryman Feed-Water Heater.

the exhaust steam as often as there are rows of tubes in the heater and obtaining the full benefit from the heat. Impurities in the feed water must settle to the bottom and may be blown off, the settling chamber or mud drum being concave, which gives great strength to what otherwise would be a weak part of the heater. By removing the bolts of the settling chamber, shown in the accompanying cut, the interior is accessible and the settling chamber, tube plate and tubes may be lowered and the interior reached for any purpose.

The surfaces of the large exhaust passage are arranged to arrest the cylinder oil contained in the steam and discharge it with the water of condensation, allowing the returns from heating system to be used again for feed water. The feed water enters the settling chamber and can only leave the first compartment by passing upward through the inside row of tubes. The water passes around this inside row and enters the settling chamber again, from whence it goes into the outside row of tubes. After flowing around through the outside row, the water finally enters the last compartment, to which is connected the feed-water outlet to the boiler. This makes the circulation easy, positive and frictionless and the feed water obtains the benefit of all heat in the surrounding steam. A feed-water temperature of 200 degrees Fahrenheit or above is guaranteed any non-condensing plant where this heater is installed.

An Interesting Exhibit.

We call attention of our readers to a cut showing the exhibit at the St. Louis Exposition of the Lagonda Mfg. Co., of Springfield, Ohio. These people are manufacturers of the celebrated Veinland Tube Cleaners and other specialties of which they make a very complete line.

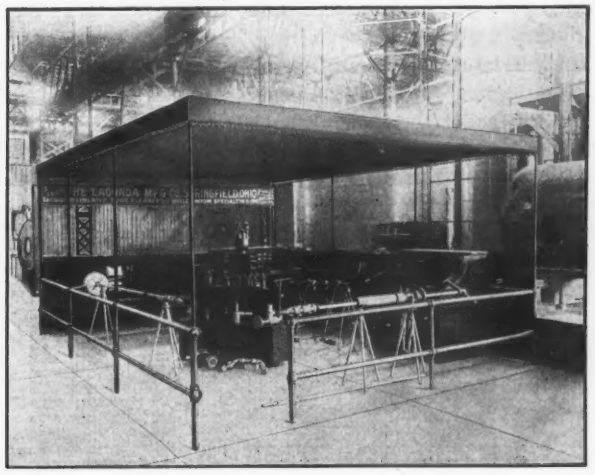


Exhibit of the Lagonda Mfg. Co., at St. Louis.

The exhibit here shown is in the Steam, Gas and Fuel Building, midway between the several types of boilers which are used for furnishing steam for the entire Exposition plant, and here may be found a great variety of cleaners, as the Lagonda Co. make different types of machines suitable for every type of boiler and for every size of tube,—Hand Cleaners, Turbine Cleaners, and Power Cleaners, so that they can successfuily meet the requirements of every customer.

In the front part of the space, inside the railing, is shown the Mechanical Cleaner, which is driven by electric motor or other suitable power. On the left hand side parallel with the railing, can be seen their Direct Motor Cleaner, which is something new in this line. It is a 12" water wheel which drives a very powerful cleaning head and with water at 150 pounds pressure, develops something like five horse power.

Between the desks can be seen their Power Driven Cleaner for cleaning the tubes of boilers that use bent tubes, with horizontal drums at the top. A very interesting machine is the large Turbine Cleaner. This is an 8" cleaner and was made specially for one of their customers. It is interesting to note the difference in sizes of machines. The smallest machine in the exhibit is but 1½" in diameter.

The photograph also shows the Reseating Machine which this Company has so successfully introduced, also their Tube Cutter and Blow-off Valve. A Damper Regulator which is made by this concern can be seen in practical use on one of the boilers, and here also those interested can see the different types of tube cleaners in actual operation, cleaning tubes in the boilers in use at the Exposition, for it seems the managers of the Exposition have selected these cleaners to be used exclusively in keeping the boilers clean. This of itself is quite a compliment to the Lagonda Co.

The exhibit is in charge of Mr. J. W. Cunn, the Treasurer of the Company, who will be pleased personally to meet any engineers or others interested in this line.

The Company has issued a very attractive little souvenir in the shape of a watch charm which they will be pleased to give to anyone who will take the trouble to call and ask for one.

The Mosher Water Tube Boiler.

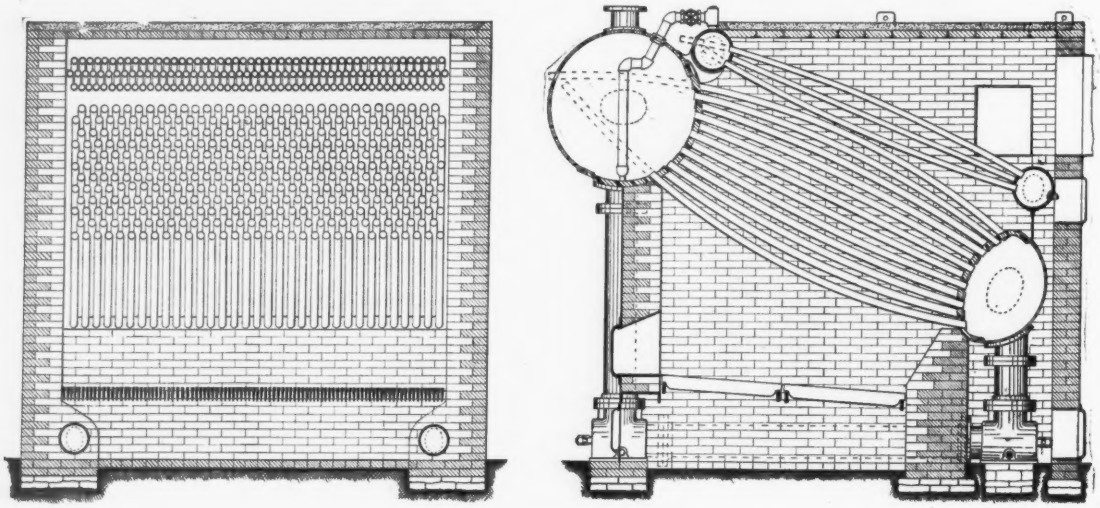
This type of boiler has for a long time been in use for marine purposes, but it is said to be equally well adapted for stationary purposes, particularly so, when the water used is laden with large quantities of impurities and scale making matter, on account of the conveniences for cleaning and repair which this boiler possesses.

By referring to the cuts, it will be seen to consist of four principal parts: the steam drum, the water drum, the tubes, and the return pipe. The steam drum is supported at each end by a return or circulating pipe with the necessary fittings, which fittings are provided with handholes. The circulating pipes extend from these fittings forward on each side with the necessary connections, also provided with handholes that support the water drums. The tubes are expanded directly into the steam and water drums and may be reached by manholes in the head of the drums. The tubes are given a slight curve and by the dotted lines it will be seen that they may all be cleaned or replaced through a single row of plug holes in the front portion of the steam drum. As many as 30 tubes may be cleaned or replaced by removing the cover from a single handhole.

This boiler also contains a feed water heater which consists of two steel drums connected by slightly curved tubes which are expanded into them. The drums are fitted with a row of handholes by means of which the tubes can be cleaned or replaced through a single handhole the same as in the boiler. The drums of the feed water heater are placed out of the path of the gases of combustion, thus preventing the possibility of injuring them, regardless of the amount of scale which may collect in them.

The path of the feed water is as follows: It is first delivered into the lower drum of the feed water heater, from which it passes up through the tubes to the upper drum of the heater, from which it is piped to the steam drum of the boiler and distributed by branch pipes with nozzles projecting into the large return pipes that support the steam drum. From the large return pipes, the water passes through the large pipes shown on each side below the grate, then up through the connections where it reaches the water drum, from which it passes directly into the tubes of the boiler.

These boilers are particularly adapted for use in basements of buildings or where there is limited space as their design is elastic. Thus, if the head room is limited, the tubes may stand nearer horizontal, or when the floor space is limited, the drums may be placed so that the tubes stand nearer vertical, with a corresponding decrease in the area of the floor space required. They can also be made shorter and wider or longer and narrower as required and are constructed with a large or small furnace and can be adapted for burning anthracite culm, low as well as high grade bituminous coals, wood, sawdust, or bagasse. The Mosher Water Tube Boiler Co., of No. 4 Broadway, New York, are the manufacturers.



Mosher Water-Tube Boiler.

Valve Troubles.

Jenkins Bros., of New York, have just issued a little book on "Valve Troubles and How to Avoid Them." Some of the important points discussed in it are as follows:

"Valve troubles may be due either to defective design, material and workmanship, or to faulty installation, lack of care or abuse.

While a valve is by no means a delicate piece of mechanism, many users treat it much the same as an ordinary pipe fitting, when by exercising a little care, considerable annoyance could be avoided.

Leaking through the seat when closed is the principal and most annoying of valve troubles, and is due to irregularity or unevenness of the seat or disc, which prevents perfect contact. Poor installation, lack of care, or abuse, are usually the cause of this trouble when good valves are used, and as other troubles are of minor importance in comparison, we shall treat of this one only.

To properly install valves, the following practice is recommended:

Piping should be cleaned out before screwing together, and if possible the line should be blown out after valves are in place. Unless this is done, loose scale or metal chips remaining in the pipes may injure the seats or discs and cause leaks, requiring regrinding, reseating or renewal of discs. Red lead or pipe cement should be sparingly used and applied to the pipe only, never to the valve; because if put in the valve it is apt to be pushed inside by the pipe, stick to the seat and cause a leak.

Before screwing on a brass valve do not remove the bonnet unless absolutely necessary; close the valve tightly to make it as rigid as possible, and use the wrench only on the hexagon next to the pipe end. If used on the other end the strain is liable to spring the valve body and cause leaks, not only in the seat but at the bonnet joint.

If absolutely necessary to remove the bonnet before valve can be screwed on, extra care should be taken not to spring the body or dent the joint. A pipe wrench should never be used for this work, as it not only cuts and disfigures the bonnet, but is apt to crush it.

The best way to loosen a valve bonnet is to hold it firmly by the squares in a good vise, screw a piece of pipe well into the valve end, then give a quick, strong pull on the pipe.

A valve should not be allowed to carry the weight of a line of piping, as this may spring the seat. A hanger properly placed has sometimes remedied the trouble with a leaky valve which could not be kept tight before its use.

For flanged valves the pipe flanges should be made up true and close, as strains that would not affect an ordinary pipe fitting may spring a seat and cause the valve to leak. Unless fitted with a by-pass, it is best to place globe or angle valves so that pressure will be underneath the disc when closed.

It is bad practice to use a wrench or bar inserted between the spokes of hand wheel in closing down a valve. When such means are employed by one not thoroughly familiar with their construction, the seat or disc is liable to be crushed and bonnet or yoke overstrained, and the practice is really dangerous. It is better to remove the bonnet and examine the valve to ascertain the cause of leak.

Valves must be designed and constructed to stand considerable abuse, and although it is commercially important to have them as light as possible, strength should never be sacrificed to lightness. Light weight valves are more easily injured than heavy ones, and are more liable to give trouble.

No matter how much care may be given to their installation and maintenance, the use of cheap and inferior valves is sure to prove troublesome and expensive and detract greatly from the efficiency of a steam plant, and in order to insure perfect satisfaction with the minimum of care and attention, valves should be selected of approved merit and reputation and which are guaranteed to do the work for which they were designed."

Fifth Anniversary of Northeast Association.

On Saturday afternoon and evening, September 3rd, Northeast Association, No. 20, N. A. S. E., of Philadelphia, celebrated its fifth anniversary at Leiderkranz Park, Tacony, and the affair was a magnificent success as well as a credit to the committee in charge. The members of all the other local N. A. S. E. Associations were invited and also numerous friends from other places. In all, there were about five hundred in attendance, including many ladies, and all enjoyed themselves immensely. The feature of the day was a ball game between Northeast and Merrick, with Joe McKenna as umpire and Frank Duemler keeping score. The score was 28-8, when a committe of ladies announced supper and McKenna called the game on account of darkness, but we noticed that it wasn't too dark for Joe to eat a pretty big supper, and, right here, boys, let us tip you off! If you are looking for a girl who knows things about culinary, go to Tacony, that supper was great. In the evening, there was music, dancing, speeches and popular songs, making in all a most delightful entertainment. The singing was chiefly by Herbert Self, of the Crandall Packing Co., and Joe McKenna, the popular Brooklyn representative of the Dearborn Drug and Chemical Works. G. Frank Duemler, Philadelphia manager for the same firm, acted as master of ceremonies, in which he was ably assisted by other members of his Council. Mr. Duemler organized Northeast Association and is justly proud of it.

Old Colony.

The meeting nights of Old Colony Council, No. 14, of Rockland, Mass., have been changed to the first and third Wednesday of each month.

New Quarters for Lehigh.

Since the recent convention of the Supreme Council A. O. S. E., at Allentown, Lehigh Council of that city has made some decided improvements. They now meet one story nearer the street; namely, the second floor of the Lawfer Building, where they have handsome large quarters all to themselves, carpeted and furnished beautifully.

Many models of steam specialties and appliances are on exhibition in the rooms, including a Corliss engine and dynamo. The Council will be pleased to find space for other samples and models of anything in the line of steam plant equipment or supplies. Those desiring to communicate with the Council should address A. P. Dreisbach, 728 Chew St., Allentown, Pa.

TRADE NOTES

E. Fearon Company, 110 Oxford street, Philadelphia, have just opened new shops for machinery repairs, under the management of Mr. James Fearon, formerly master mechanic for the Quaker City Dye Works and well known as a mechanic of exceptional ability. The new company will devote their attention chiefly to repairs of steam engines, pumps, etc.

Owing to the recent death of Mr. R. S. Spencer, who has for many years represented the Direct Separator Co. in Philadelphia and vicinity, this well-known firm have found it necessary to make other arrangements. Hereafter Mr. A. Don. Heyl, of 1609 Filbert street, Philadelphia, will look after their interests in this city, and any business referred to him will receive prompt attention.

Mulconroy & Co., formerly of 1215 Marstreet, Philadelphia, have removed to 722 Arch street, where they will carry a large and very complete line of packings and mechanical rubber goods.

A jug of water is all they ask. That's easy, isn't it? Then the Continental Chemical Co., 2923 N. Broad street, Philadelphia, promise to send you a free analysis and to prescribe a cure. If you don't want the analysis, write for their booklet; it contains some warm arguments.

The Sterling Pipe & Blower Co., of Hartford City, Conn., have recently received an order for a 24-inch and an 8-inch Sterling exhaust pipe head for shipment to the Philippines. The exhaust head department of this company has grown so rapidly that it is now one of the most important departments of their enormous sheet iron factory. Their business has increased to such an extent in all departments that they have recently doubled their floor space. In a year of business depression this speaks volumes.

Engineers should endeavor to learn as much as possible about every valve on the market, and certainly should understand the construction and operation of those valves which are specially designed for very high pressures. He should also know the various uses for which each valve is specially intended and the sizes in which it can be obtained from stock, as well as the prices of each. In this connection, a little catalogue published by the Homestead Valve Co., Box 1754, Pittsburg, Pa., will be of interest to all. A copy will be sent upon request.

The Webster system of steam circulation will be installed in the new department stores of John Wanamaker in Philadelphia and New York. The Webster system was used in the old Philadelphia store for six years, and gave such satisfaction that it was adopted for the new stores, which are the largest buildings of their kind in the world.

One of the best rewards ever given to engineers for a little thought is offered by the Federal Valve Co., 2534 Western avenue, Seattle, Wash., who manufacture the Mullins Automatic Controller for Boiler Feed Pumps. On page 48 of this issue of The Practical Engineer will be found a sectional view of the valve. Don't fail to look at it. Fifty dollars will be given for the best reason why it works, $30 will be given to the second best, and 20 to the third best reason.

So write to them and give them your idea. If it's good, you stand a chance of winning one of the prizes.

A sample bar of Stephenson Bar Belt Dressing will be sent free to any reader of The Practical Engineer upon request. Address Stephenson Mfg. Co., Albany, N. Y.

Don't kick, even if your pump does. Write to the Lackawanna Pump Works, Walnut street and Capouse avenue, Scranton, Pa., for a copy of their new catalogue, which tells about a pump that never kicks.

Mr. Chas. M. Eddy, secretary and treasurer of the Dearborn Drug and Chemical Works, was a welcome visitor at the offices of The Practical Engineer during the past month.

If you are troubled with vibration in your steam mains, try the Simonds Receiver and Separator, built by Frank A. Simonds, 421 Houseman Building, Grand Rapids, Mich.

Mr. Chas. S. Platt, secretary and general manager of the Norristown Covering Co., Norristown, Pa., has just returned from a business trip through New York State, where, he informs us, he found the outlook for new business very encouraging indeed. He says there is plenty of new work in sight. In fact, the factories of his company have already had to run nights to fill orders, despite the fact that the covering season is only just commencing. Mr. Platt says they expect to make this their banner year in spite of the fact that a great many people are complaining of dull business. Verily, you can't keep a good thing down.

"A Brief History of Lubrication" is the title of a little booklet published by the Keystone Lubricating Co., Twentieth and Allegheny avenue, Philadelphia. It is interesting and will be sent free to engineers upon request. A large can of Keystone Grease and a brass cup will also be sent free to any engineer mentioning The Practical Engineer.

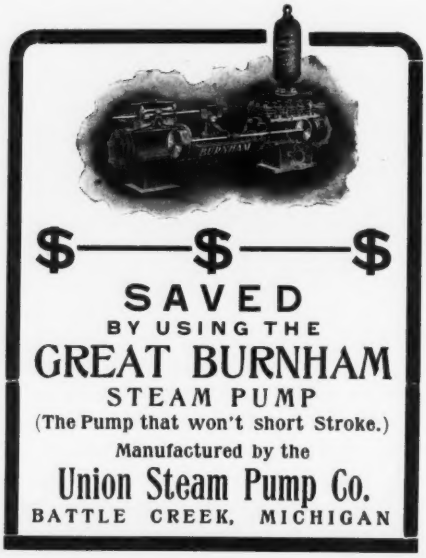
The new home of the O. F. Zurn Company, the popular Philadelphia oil house, at 23 and 25 South Fifth street, next door to the Bourse, is an attractive and excellent location. The engineer friends of the company are invited to call and see the new place when in the vicinity.

The big four of a steam plant as defined by Richard Thompson & Co., 126 Liberty street, New York, consists of grate bars, tube cleaners, damper regulators and indicators. If these four articles are properly made and installed, Mr. Thompson thinks, the engineer should be able to run the plant economically. Mr. Thompson has had over twenty-five years practical experience in the manufacture and use of these articles, and he sums up their virtues as follows:

Grate Bars.—The object of a furnace grate is: to support the fuel without waste; to supply through its spaces the necessary amount of air uniformly and in every part of the furnace for the purpose of combustion, and to be of such construction as to maintain an even surface with sufficient strength to insure durability. Both shaking, dumping and stationary grates of this construction are shown in Booklet F.

Tube Cleaners.—The soot ejector or injector blower (according to conditions) will clean the tubes quickly and thoroughly. They are used very extensively and sent on approval. Booklets C and D explain them.

Damper Regulators.—That a uniform pressure on steam boilers is desirable, beneficial and economical is admitted by all steam users. When the proper pressure for the load on engine is ascertained, the regulator should be set at that point. If you use a Thompson Regulator it will do the work to perfection. It will operate one or a dozen dampers within one pound variation of steam. It is also a great coal saver. Four of these



regulators operate the dampers of the largest power house in the United States. They are fully illustrated in Catalogue T.

Last but not least is an indicating outfit. No steam plant is properly equipped without one. It is to an engine what a safety valve is to a boiler. It should be used regularly. Diagrams when properly taken show the operation of steam in the cylinder. Valves can be properly adjusted and the correct steam pressure for the load determined. It may be termed looking at the inside of a steam engine in operation. There are a number of indicators in use, but the Thompson can always be depended upon to show accurate results. It is described in Booklet A. Any of these booklets will be sent upon request.

An Indicator Free is the offer which the Indicator Instruction Company, of Scranton, Pa., has been making, and they inform us that this offer has resulted in so many enrollments that they have been practically swamped with business, which has made them very much in arrears. They advise us that while this state of affairs has been flattering, yet it has been annoying both to themselves and their students, and they have added to their facilities and are now in shape to take care of all business promptly. About October 1st they will open an office in Philadelphia, Newark and New York. They already have an office at 28 School street, Boston, Mass., so that engineers in the vicinity of these cities by writing to the Scranton office may have a representative sent to them without delay.

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Most engineers' supply houses carry the Climax Steam Joint Clamp in stock, and a good many steam plants have some leaky joints to look after, or will have when the first cold snap comes. The Climax is an effective and economical remedy. The manufacturers are James McCrea & Co., 67 West Washington street, Chicago, Ill.

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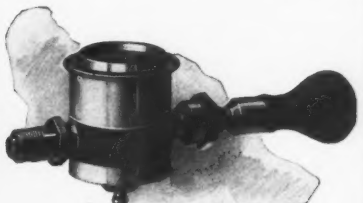

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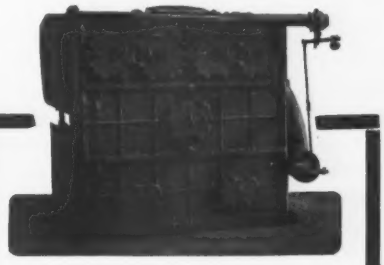

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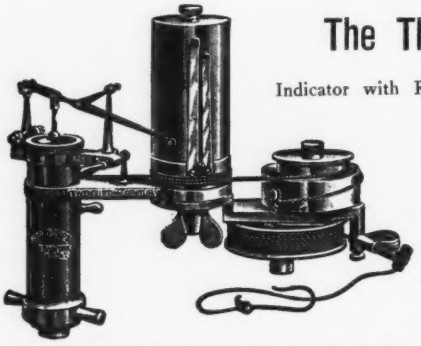

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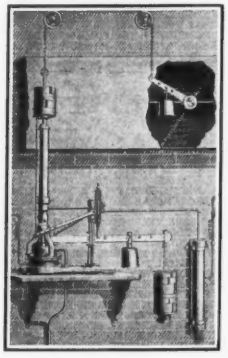

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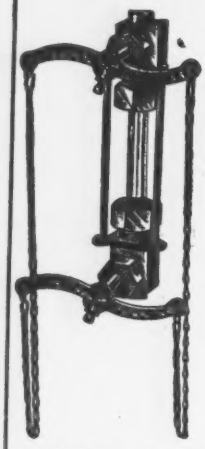

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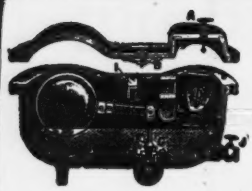

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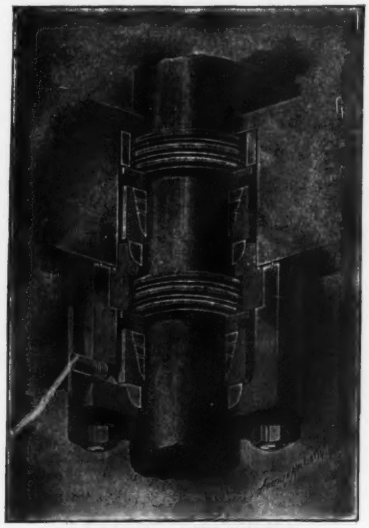

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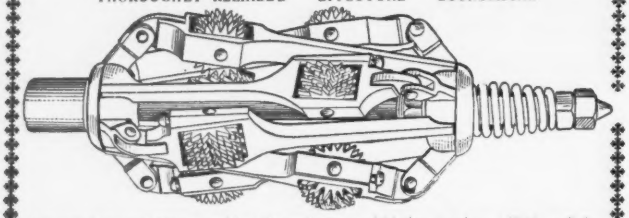

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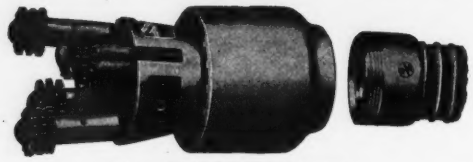

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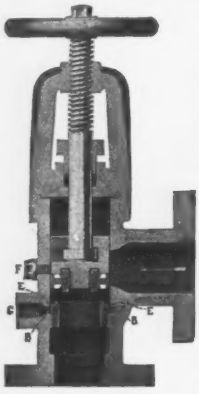

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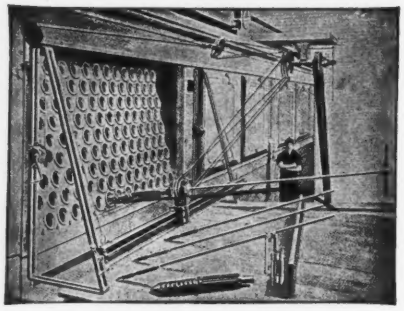

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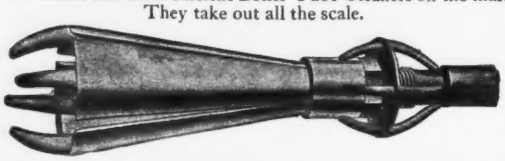

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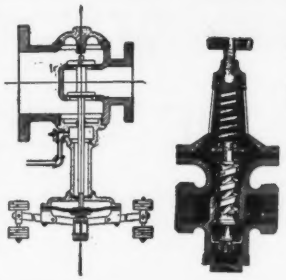

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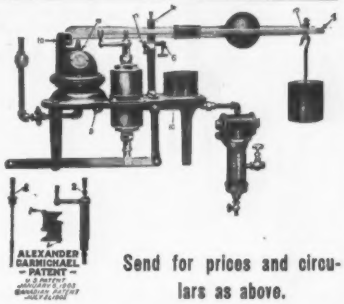

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YOU CAN'T LOSE--

Our plan is so simple and fair and square that you can't lose.

Universal Belt & Pulley Reg. Co., New York — Brooklyn, Mar. 15, 1904.

GENTLEMEN:—The covering which you put on our pulleys at our factory, 28 & 30 Rodney Street, Brooklyn, has proved eminently satisfactory. Prior to its being put on one of the motors which drove the line shafting had to be set at an angle in order to keep the belt on the pulley. Since the application of your covering the motor has been squared up and is running perfectly straight.

We take great pleasure in recommending the covering. Yours truly,

WATERBURY & CO.—Per Geo. W. Nock.

THE UNIVERSAL BELT AND PULLEY REGULATOR

is sold on a thirty day trial. Can anything be fairer than that? **It is guaranteed to last five years. Pulleys re-covered free of charge if worn off before end of time started.** For either iron or wooden pulleys. It's to prevent slipping too. Send us the size of the pulley you wish to cover and we will give price of work complete.

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Also 500 other things including every article, tool or device an engineer may want. For Free premium list and full particulars regarding this remarkable offer, fill out and mail us the coupon below.

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Gentlemen:

Kindly send me premium list and full particulars regarding the indicators and other articles you are giving to engineers.

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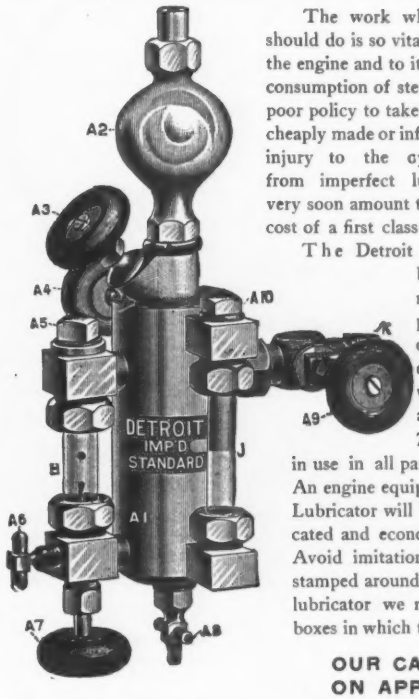
Give Complete Address.

The Importance of a Reliable Lubricator



The work which a lubricator should do is so vital to the welfare of the engine and to its efficiency in the consumption of steam that it is very poor policy to take any chances with cheaply made or inferior goods. The injury to the cylinders, resulting from imperfect lubrication, would very soon amount to several times the cost of a first class lubricator.

The Detroit Lubricators have been used by fully nine-tenths of the prominent builders of American steam engines for upwards of 25 years, and there are over 700000 of steam in use in all parts of the world. An engine equipped with a Detroit Lubricator will be perfectly lubricated and economically operated. Avoid imitations. Our name is stamped around the body of every lubricator we make, and on the boxes in which they are packed.

OUR CATALOGUE ON APPLICATION

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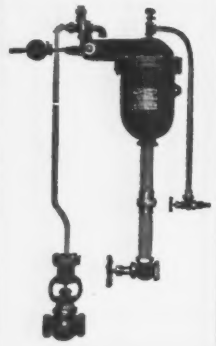

INSTALL THE

Vigilant Water Feed Regulator

THEY WILL PREVENT A DOSE OF WATER IN YOUR ENGINE CYLINDERS.

Let us send you a list of users that you may investigate. Write

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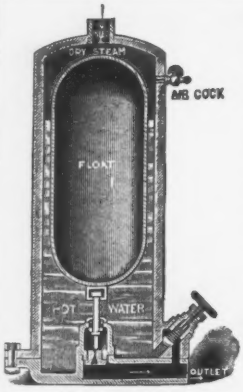

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Is the best for your purpose is—It has no levers and toggle joints to wear; Only one valve, which has bronze valve and seat; The float is guaranteed to withstand 300 lbs. pressure; Thousands in use satisfactorily on both high and low pressure; All traps guaranteed to give satisfaction and the price considerably less than any other first-class trap on the market.

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STEPHENSON BAR BELT DRESSING

GOOD ALL THE TIME.

GREAT IN EMERGENCIES.

Why shut down to take up a slack belt if it can be made to do its work without?

Keep the wheels turning.

Save the lost time of idle hands.

Cement a three-corned friendship between your employer, yourself and us by writing us for a FREE SAMPLE and testing it.

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For hydraulic and low pressure steam joints, gaskets, etc. It is press cured material, natural gray rubber color, cloth insertion, all thicknesses. Why pay 50 cents per pound for fancy packing? Send for sample.

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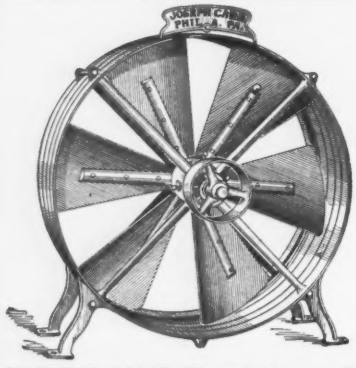

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Prices on Application.
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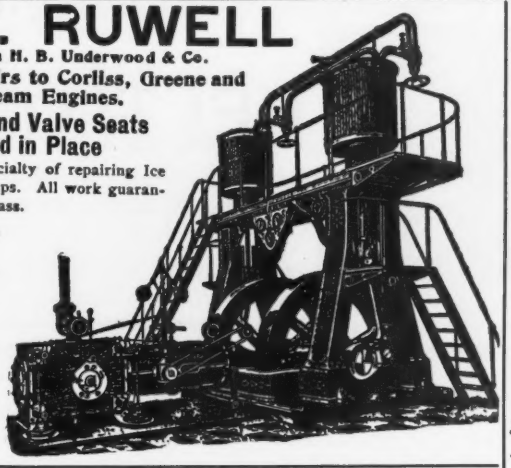

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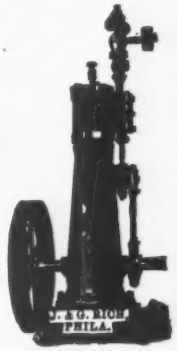

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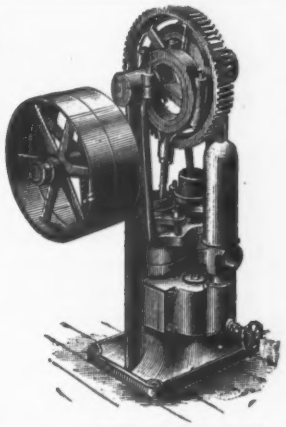

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Walsh Metal Face Packing

A—Fibrous Packing. **B**—Metal.
C—Open space to avoid butting when cover is worn off.
D—Section of metal cut out at C.

Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

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Walsh Combination Gaskets

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Can be used from 10 to 40 times. The Cheapest Gasket Made.

A—Soft Metal. **BB**—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets.

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impure water if you can get it pure; then why feed your boilers on a water that is going to lead to a youthful grave and to early gray hairs.

The Water softening plant here shown is assuring a long life for the boilers and rendering the lives of the men about them safer and more enjoyable.

We are always happy when mailing our booklet and figuring on a plant. : : : : :

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IF SOME FELLOW offered to take your job for less pay than you get, you'd say there was something wrong with him; if he was all right, he could get standard pay. The man who makes your overalls acts on the same plan; if he makes an inferior article he has to sell them at a lower price and your overalls will cost you far more per year than if you buy the best, the

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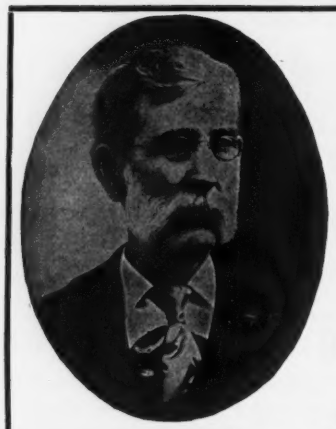

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McNELLEY'S AMERICAN BOILER COMPOUND

Our compound is the result of years of experiments by an engineer of long experience, assisted by expert chemists.

American Boiler Compound not only completely removes all scale and incrustation in the boiler, but prevents new from forming, and will, if properly used, keep the boiler absolutely clean and free from all forms of corrosion, such as pitting, grooving, honeycombing.

Send Sample of Water and Sample of Scale if Convenient.

We will be pleased to hear from engineers who will secure trade for us. When writing for information address

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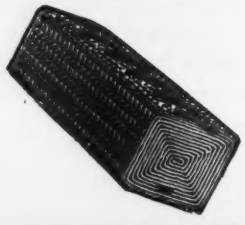
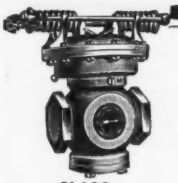


This represents another of our high-pressure packings. It's composed of metal strips firmly embedded in asbestos.

Like all good things it is imitated, therefore — Remember the "Trade Mark" none other is Genuine.



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For general service—the regulation of high pressure we claim our CLASS "W" VALVE to be peerless, it is noiseless very sensitive, frictionless and has neither dashpot or small ports—it may be adjusted to pressure desired and once adjusted becomes entirely automatic in action, maintaining a constant high delivery pressure regardless of variation in initial or boiler pressure.

FOSTER BACK PRESSURE VALVE has neither weights, levers or direct acting springs—**Guaranteed not to shatter.**

We will gladly send full details of these valves as well as many other Foster Pressure Regulating Devices.

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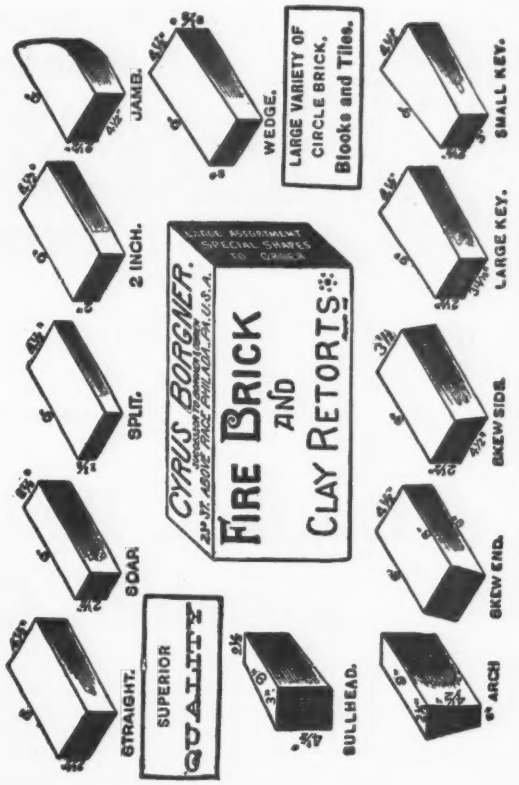
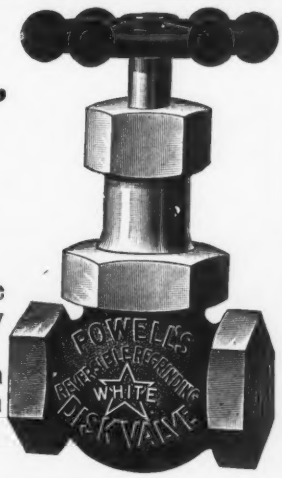
NEWARK, N. J.



Powell's "White Star" Regrinding Reversible Seat Valves



have a longer life and are easier to repair than any valve made.

They are sold with a guarantee of satisfaction or your money refunded.

Try one.

Wrought Iron Pipe

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RING PACKING

In ordering give EXACT diameter of stuffing box and piston rod or valve stem.

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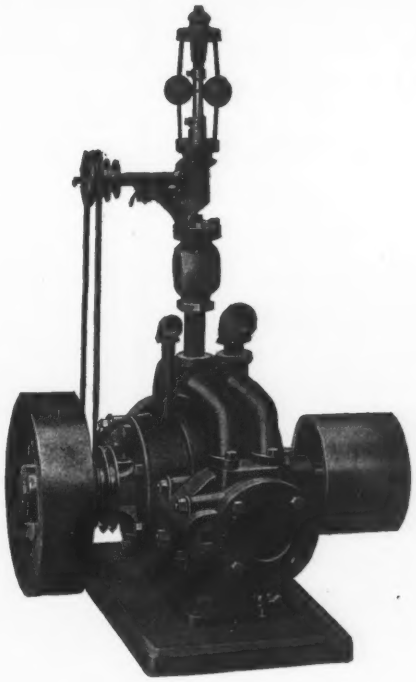

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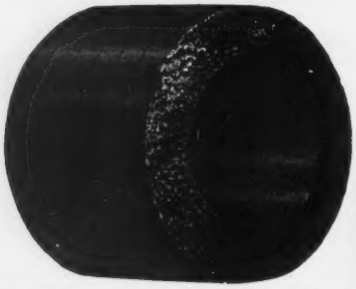
For driving special tools and machinery.
Driven by steam or compressed air.
Floor space 19x19 inches, weight 147 pounds. Equal to any electric motor and more economical.
Easily taken apart, easily assembled.
No shop is complete without at least one of these handy little engines.
Can be used for a thousand different purposes, and will save its cost a dozen times a year.

THIS LITTLE MOTOR IS

New, Novel and Mighty Useful

Look at it. Read about it and think about it; perhaps there is a place about your establishment where you can place one to advantage.

Write for circular and price



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Can't blow out or burn—pliable and elastic—reduces friction—will not scratch or corrode the rod—always fits and any body can fit it. It's the handiest, most durable and most economical packing.

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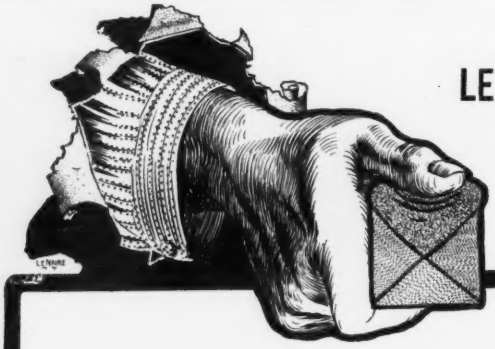

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BLACK SQUADRON will outwear, outlast any self adjusting packing on the market.

This is true, all true, but we don't and won't ask an engineer to buy BLACK SQUADRON on hear say—our word or any one else's. We want to prove it "the best by test," therefore we will send FREE EXPRESS PAID a supply of BLACK SQUADRON to any engineer who will send us his name and business address.

We have a few more engineer's books left and will send one FREE of COST; at the time we send the Free Supply of packing.

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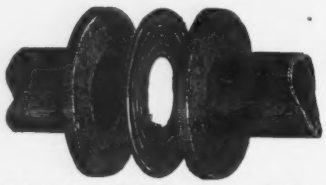

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They Save Steam and Make Absolutely Tight Joints

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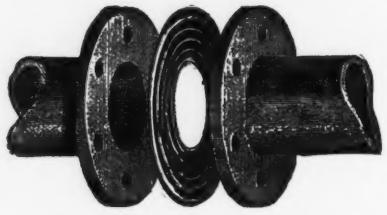

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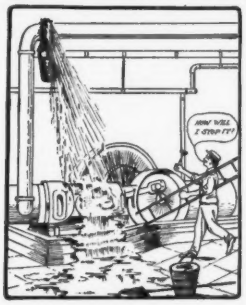

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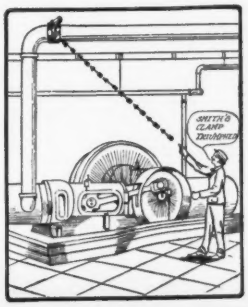

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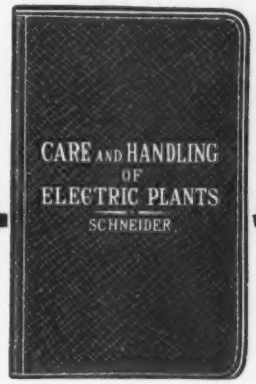

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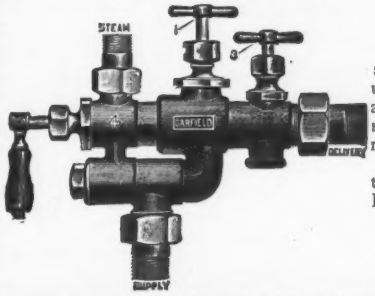

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starts at 15 lbs., lifts 25 ft. and works hot water up to 150 degrees under proper conditions. All are made extra strong and heavy and of the best material, thus insuring long life and small cost for repairs.

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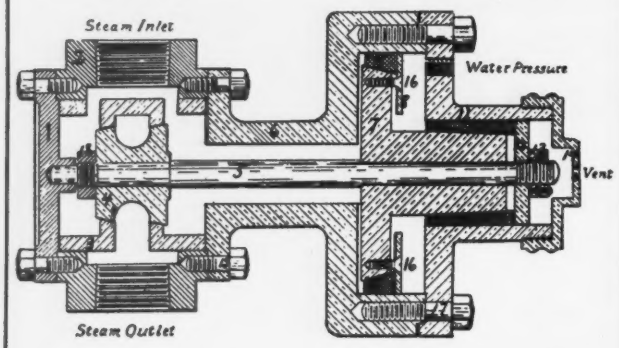

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This is an instruction book for engineers in charge of steam plants. It is practical and in comprehensive language. It covers the whole field of steam engineering practice and it also contains 200 questions such as an engineer is likely to be asked when being examined for license.

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FOR USE ON SEPARATORS

One of the main advantages in using a live Steam Separator is that it protects the engine from danger by water.

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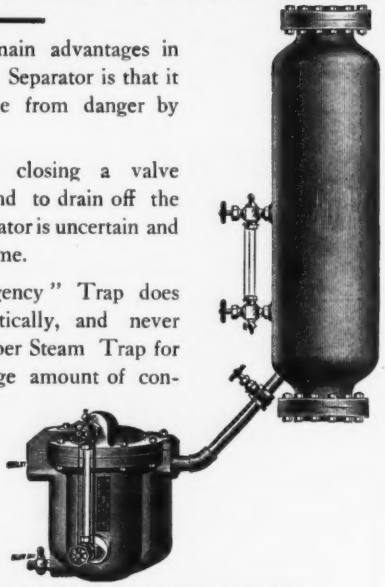

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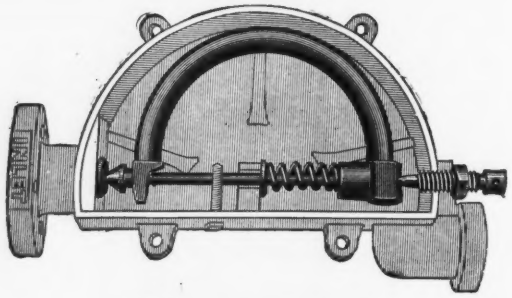

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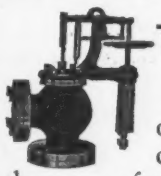

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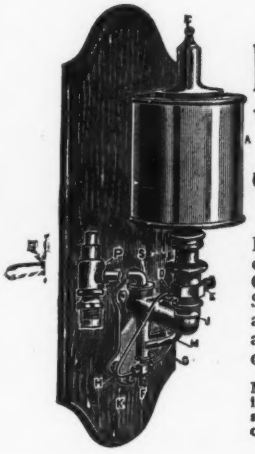

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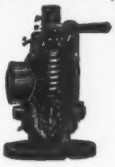

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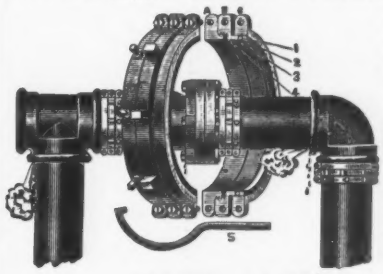

in use for seven years against 150 lbs. pressure and have never leaked a drop is the statement of one of our first customers; and during that time they have used more than fifty C. S. J. Clamps of different sizes. They realize the economy of using them. Would it not pay you to try them? There is an agent in nearly every city.

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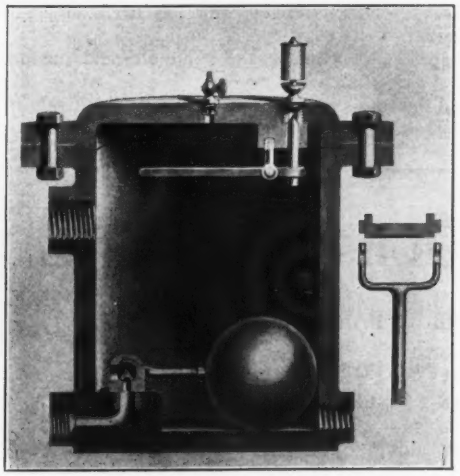

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The enormous sales of this packing attests the high favor in which it is held by hydraulic engineers

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Made in all forms, sizes, shapes and thicknesses for handholes and manholes of every make of boiler.

Made of special asbestos and fine brass wire. This gasket is positively heat proof, and it cannot vulcanize or blow out under any steam pressure.

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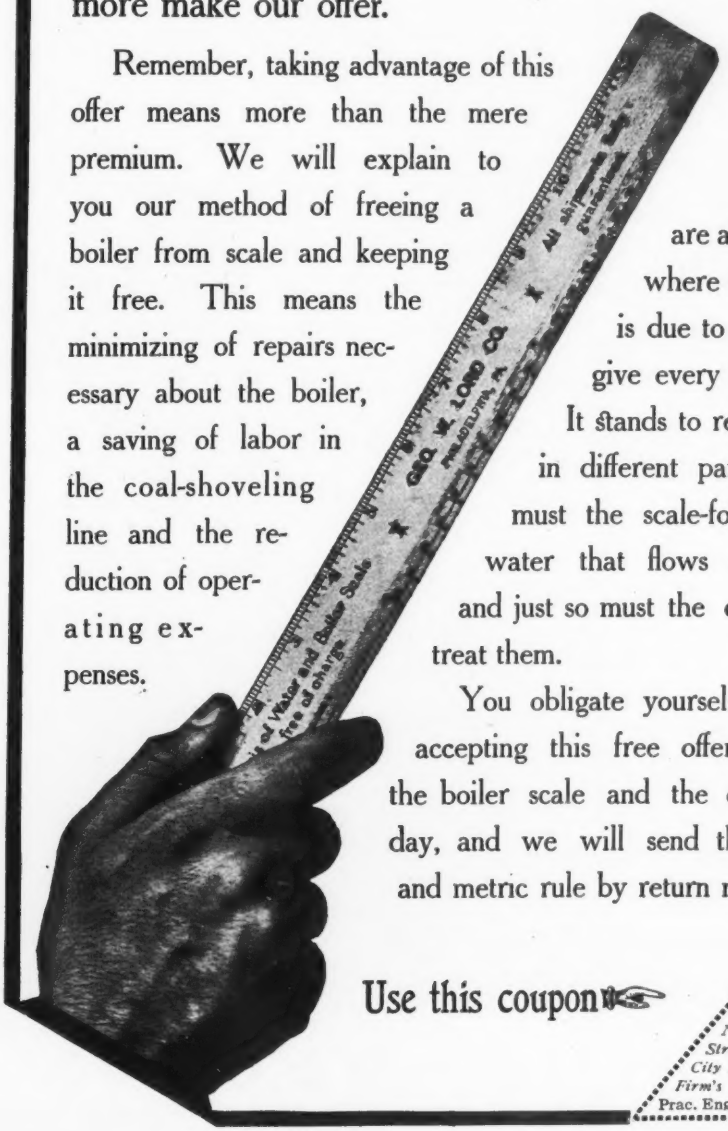
Although many engineers have availed themselves of the opportunity to get an inch and metric scale free for a sample of boiler scale, we think there are a few who have delayed. For these few, we once more make our offer.

Remember, taking advantage of this offer means more than the mere premium. We will explain to you our method of freeing a boiler from scale and keeping it free. This means the minimizing of repairs necessary about the boiler, a saving of labor in the coal-shoveling line and the reduction of operating expenses.



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are always successful—they work where all others have failed. This is due to the fact that we actually give every boiler individual treatment. It stands to reason that just as soil varies in different parts of the country, just so must the scale-forming matter vary in the water that flows over these various soils, and just so must the compound be varied to treat them.

You obligate yourself in no way by accepting this free offer. Just send the boiler scale and the coupon today, and we will send the inch and metric rule by return mail.

Use this coupon ☞

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Geo. W. Lord Co.
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Gentlemen: I am sending you a sample of scale from our boiler. You are to analyze it, and send me, free of charge, a certificate of analysis and the inch and metric foot rule.

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IMPROVED TO DATE

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This means a reduction of from 10 to 20 per cent. of the coal bill.

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Every engineer knows how extravagantly steam pumps use steam. The power required for a Belt Pump would hardly be missed. And it is not necessary to buy one of the expensive kind. Ours is simple, strong and fully guaranteed.

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Are you tired of having that exhaust pipe spattering greasy spray over the roof, walls, walks and your clothes? Possibly the neighbors are too.
Wouldn't it be better if the vapor floated away *dry and noiselessly?*

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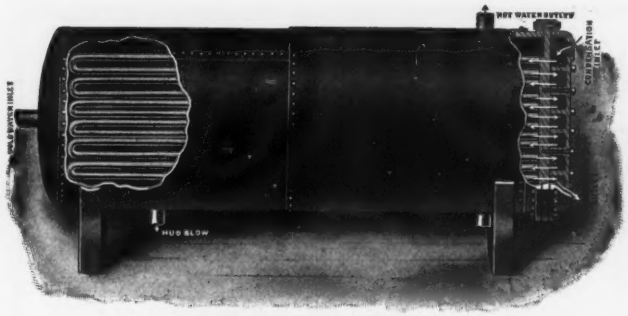

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The **Gleaner** represents the acme of perfection in feed water heating.

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is a perfect type of the vertical triplex belt driven pump.

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THE **OTIS** Tubular Feed

WATER HEATER, OIL SEPARATOR and PURIFIER

with Seamless Brass Tubes

Guaranteed

To heat the feed water to the boiling point (210 or 212 degrees) with the exhaust steam without causing any back pressure, **also to extract the oil from the exhaust**, so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the additional expense of an eliminator.

A Liberal Offer

If this heater fails to give satisfaction in every respect, we pay freight, cartage, etc., both ways.

The Stewart Heater Co.

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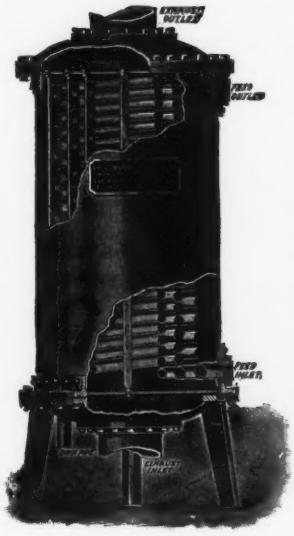
THE AMERICAN STANDARD COPPER COIL FEED WATER HEATER



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Strength!
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A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

That's the kind of a Heater you want.

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When a boiler explodes, because scale has formed in it and weakened the plates, you hear about it. But when

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keep the water pure and the boilers sound you hear nothing about it. Over 1,400,000 h. p. of Webster Heaters are steadily at work preventing accidents, and saving lives and money, and no noise is made about it.

If you want to keep your establishment quiet and happy, send for booklet F 13.

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EXHAUST MUFFLER, OIL SEPARATOR, RETURN TANK, PUMP GOVERNOR AND FEED WATER HEATER

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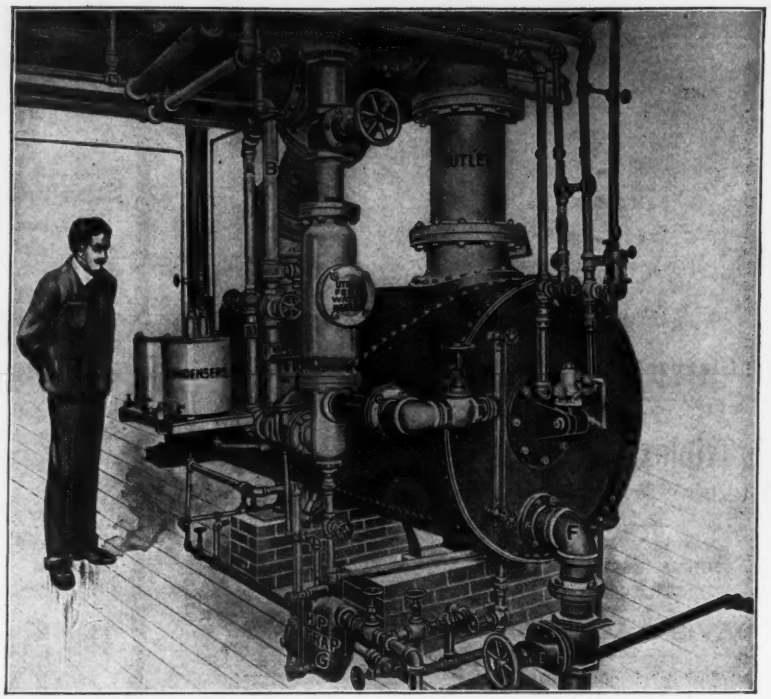

The "Utility" Combination

Serves as exhaust muffler, oil separator, return tank, pump governor, and feed water heater. It costs only about as much as a feed water heater, and heats the feed water to about the same temperature as the exhaust steam.

We mention a few of the late and up-to-date plants that have adopted the "Utility" Combination

R. H. MACY & CO.,	3,000 H. P.	HOTEL BELMONT,	2,000 H. P.
METROPOLITAN LIFE INS. CO.,	1,900 "	MUSEUM OF NAT. HISTORY,	1,800 "
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WASHBURN WIRE CO.,	1,000 "
MERCHANT'S REFRIG. CO.,	800 "
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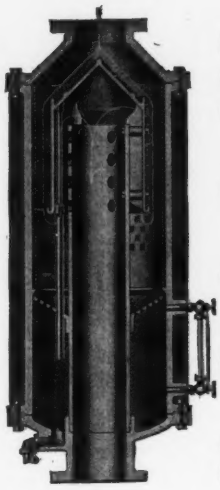
Why was the "Utility" selected for these and many other steam plants? Because we have proven by chemical tests that our system according to horse power saves thousands of dollars per year in running expenses. We can do the same for you.

"Utility" Pump Governor Best Pump Governor on the market because the Valve will not leak or stick. We guarantee it to absolutely govern the pump and remain tight for five years.

THE STANDARD STEAM SPECIALTY CO., 542-544 W. Broadway, CITY OF NEW YORK. "Utility" Steam Specialties.

PHILADELPHIA OFFICE: 341 Bourse Building.

Sweet's Separators



Our steam separators deliver steam containing less than one half of one per cent. of water.

Our oil separators remove 99 per cent. of the oil.

We can prove they do it and give good reasons why.

In addition they have size and are machines.

Made in all styles, also make Exhaust Heads and Steam Traps.

Direct Separator Co.

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Baum Steam Separators

VACCUM STYLE

Oil Extractor

STANDARD FORM

Protect 6,500 H. P. Engines.

Baum Vacuum Oil Separators

Purify and Exhaust from same Engines

Can be seen in operation, Blocks 45, 46, 50, Machinery Hall. Our Exhibit, Bock 22 Machinery Hall.

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Horizontal Style for live Steam or Oil Service.

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Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes.

We Build Heaters for Every Purpose and Condition

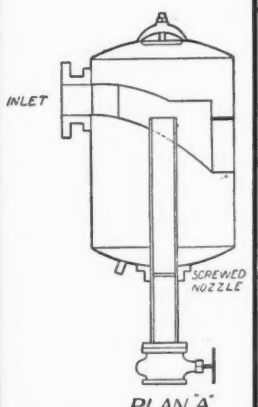
THE KELLEY PATENT

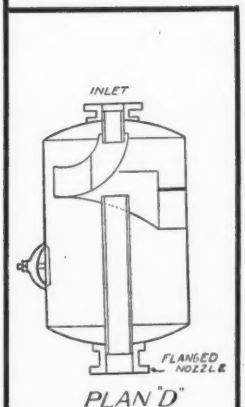
IMPROVED BERRYMAN WATER TUBE FEED WATER HEATER AND PURIFIER

Benj. F. Kelley & Son - Makers

91 Liberty Street, NEW YORK

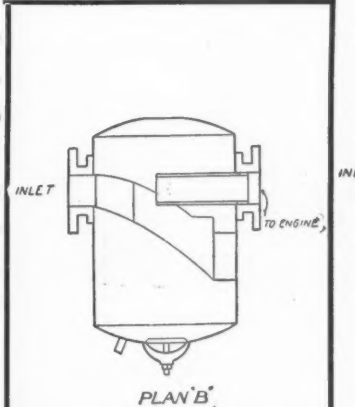
The Simonds Steam Receiver and Separator

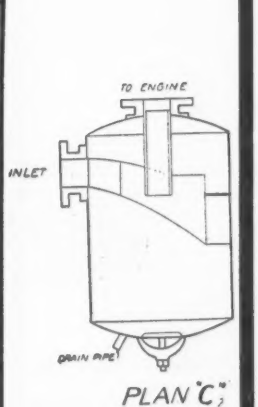




IS BUILT TO FIT ALL CONDITIONS OF PIPE CONNECTIONS, AND EACH IS PORTIONED TO THE CONDITIONS UNDER WHICH IT IS TO OPERATE.

Manufactured By





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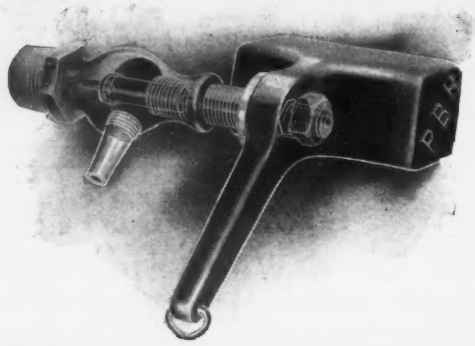

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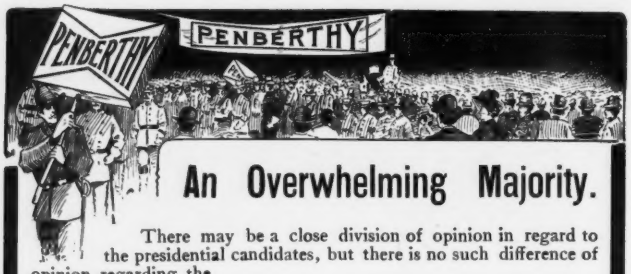

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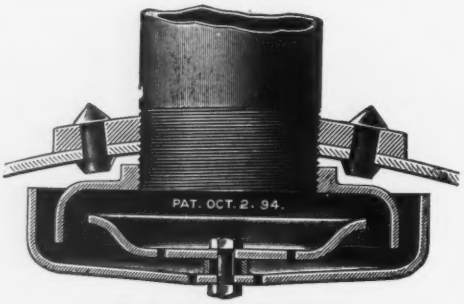

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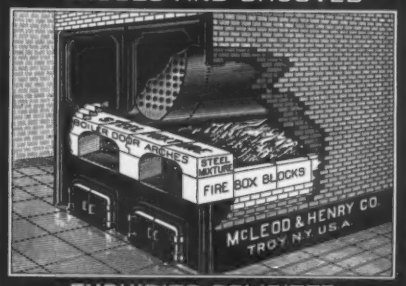

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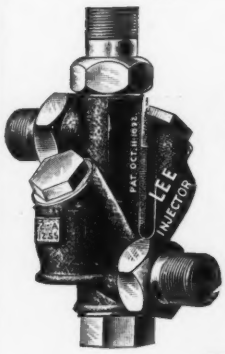

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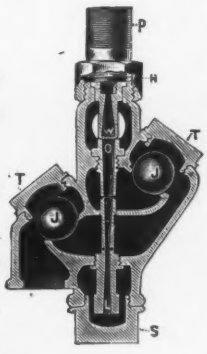

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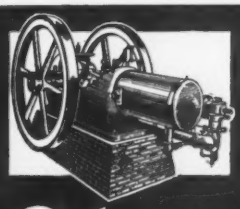

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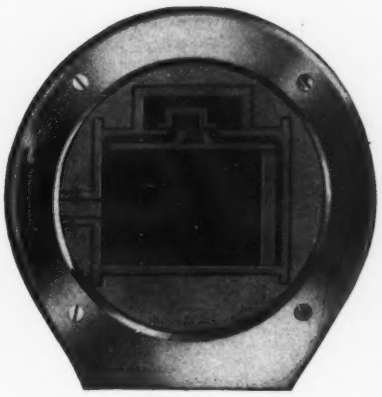

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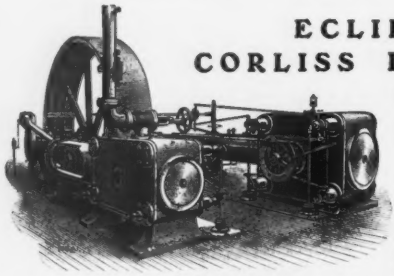

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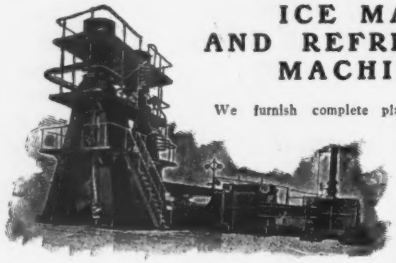

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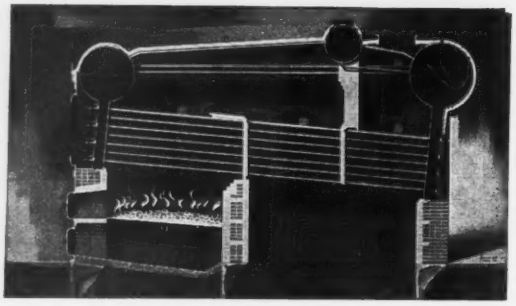

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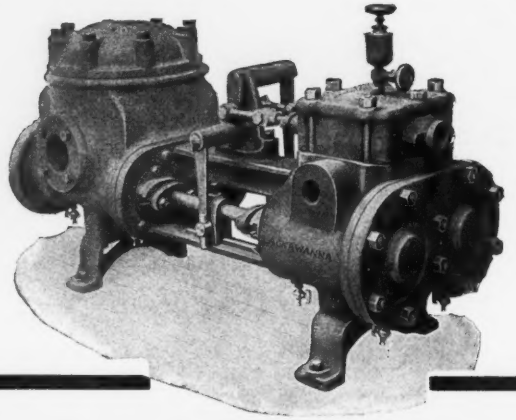

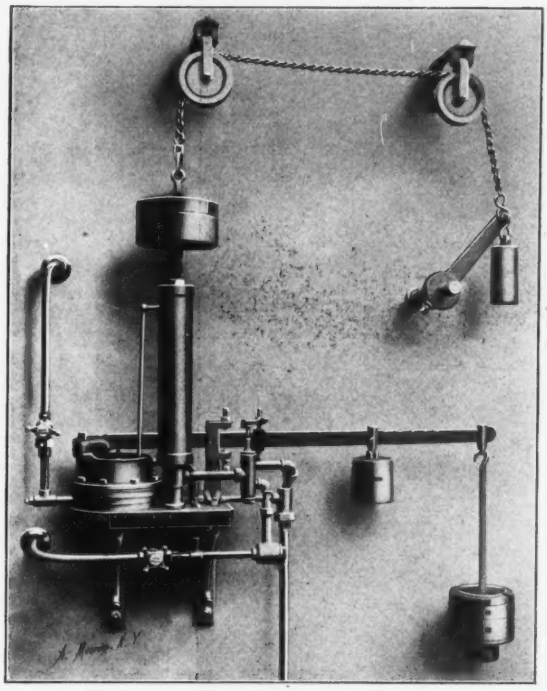

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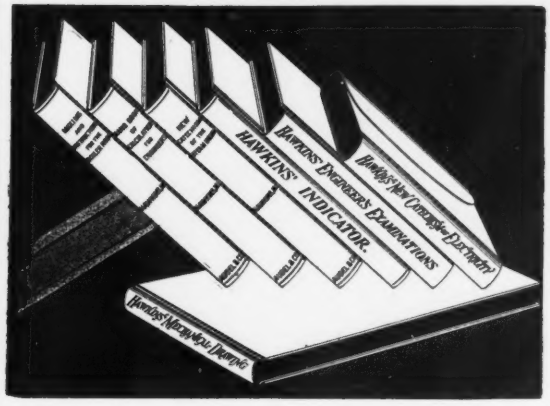

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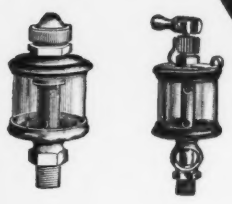

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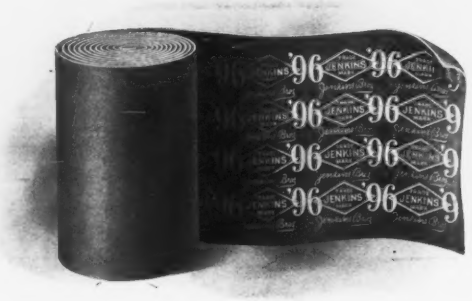

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